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COUNTERMINE WARFARE ANALYSIS FINAL REPORT

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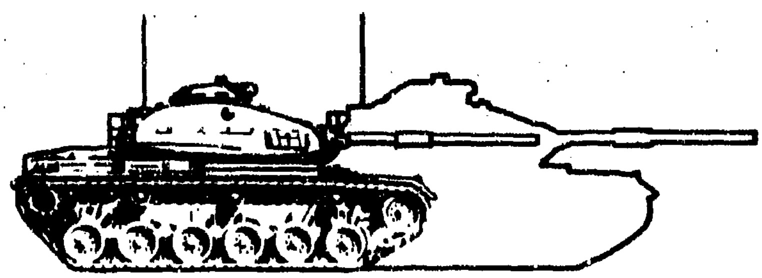

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COUNTERMINE WARFARE ANALYSIS. FINAL REPORT

June 1981

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PREFACE

This document, entitled "Counter Warfare Analysis," was prepared for the U.S. Army Mobility Equipment Research and Development Command (MERADCOM). The countermine warfare analysis was performed under Contract DAAK 70-79-C-0040, VEMASID--Vehicle Magnetic Signature Duplicator.

The Countermine Warfare Analysis was conducted by members of the Mission Analysis Group within the Honeywell Defense Systems Division. The Mission Analysis Group is located at 600 Second Street Northeast, Hopkins, Minnesota 55343.

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SECTION I.

INTRODUCTION AND SUMMARY

A. INTRODUCTION

During World War II, both the Allied and Axis powers developed and fielded new weapons and combat vehicles to meet the changing requirements of the battlefield. New doctrine was developed and innovative tactics were implemented in an effort to attain victory. New communication systems were used to gain significant improvements in command and control. With their considerable resources marshalled, both sides prepared for large-scale offensive operation.

In accordance with sound military principles, the belligerants mounted attacks against positions where their opponent's were supposedly inferior in strength and combat capability. However, in repeated instances, the attacking forces were stopped on the battlefield by mines emplaced by the enemy. In numerous cases, the superior force was not only halted, but was then shot to pieces as it was immobilized by the seemingly "inferior" enemy. The advancing unit first lost its mobility, was not able to effectively employ its available firepower, and was then defeated by gunfire and the ingenious employment of minefields which delayed and disrupted its operations.

Landmines were used extensively during World War II and were often used in Korea and Vietnam, yet their decisive effects and the resultant tactical gains were not widely publicized. Mines were the "silent soldiers" and became the unrecognized but devastating weapons of modern warfare. In Charles McDonald's history of World War II, "The Siegfried Line Campaign," the author made the following statement:

> "Nothing was more feared than mines. They were insidious, treacherous things hiding in the deep grass and in the earth."

The lessons learned regarding the need for countermining systems have apparently been forgotten. While there is currently a strong impetus to develop and field highly effective scatterable mines, there has been no commensurate activity to do the same for countermining systems. As General Donn Starry stated in his 1970 book entitled "Mounted Combat in Vietnam,"

> "The wisdom to learn from experience without merely getting better prepared to relive that experience, is not easily won. But win it we must. We owe it to ourselves and our country. More, however, we owe it to the brave men who went, helped us learn the lessons, and paid the price of learning. They left us a large legacy -- larger perhaps than we deserve."

The analysis reported in this document was undertaken to review the lessons learned about countermining. They certainly exist, and as General Starry stated, the price of learning has been paid.

The specific objectives of the Countermine Warfare Analysis were:

- To identify the principles, precepts, and trends in mining and countermining warfare that were established in World War II combat and assess their relevance to contemporary warfare, and

- To determine the potential impact of countermining operations on the modern battlefield.

In addition, several needed characteristics of countermining systems were delineated.

B. SUMMARY

Nearly all of the technological and tactical trends in landmine warfare were firmly established in World War II. Technological innovations included the first scatterable mines -- the Italian air-delivered "thermos bomb" -- as well as command-detonated mines which were employed by the Soviets. A broad variety of nonmetallic mines were developed and fielded to defeat the hand-held electronic mine detectors then in use.

From a tactical point of view, both the Allied and Axis powers quickly recognized that mines could often be decisive in the outcome of battles. Both sides also recognized that in addition to inflicting casualties, mines offered the advantages of delaying and disrupting armor movements. Covered by direct-fire weapons, minefields became a force multiplier that enabled defensive units to hold their positions against attacks by numerically superior forces. Anti-personnel mines were emplaced with anti-armor mines to reduce the effectiveness of sappers.

As U. S. casualties produced by German landmines in World War II increased, the engineers of the Fifth U.S. Army in Europe expanded their theater training efforts. They devoted approximately 30 percent of their total training time to mine warfare. Over 50 percent of their staff training courses also addressed mine warfare. As subsequent events seem to indicate, this training was apparently the U.S. Army's high-water mark in their interest in countermine warfare.

The Soviets quickly mastered the elements of landmine warfare in World War II. They repeatedly used enormous, high-density minefields to stall and defeat German armor attacks. The Soviets are now known to have helicopter-delivered scatterable mines, which they are certain to use in the event of a conflict. They have also developed and fielded a countermine system as well as numerous mine-clearing devices. Unlike U.S. forces, the Soviets' countermining equipment has been widely issued and is readily available at the lowest level within their combat units.

As landmine warfare continued to evolve, a gap developed between mining and countermining capabilities. Mines continued to impove in lethality as significant advances were made in kill mechanisms. Numerous delivery systems are now available to emplace scatterable mines, and fuzes range from almost invisible triplines to electronic target-detection devices capable of sensing the seismic or magnetic signatures of vehicles. However, countermining systems have not made comparable gains.

General Starry, referring to his experience in Vietnam, stated in his book "Mounted Combat in Vietn[illegible]" that

> ". . . since random mining can be used against us again, we should develop equipment for swift search and elimination of such land mines. Since World War II, almost nothing has been done in this field. The mine rollers sent to Vietnam were not as effective as some 1945 equipment."

At the present time, the fundamental doctrine for mine and countermine warfare is contained in FM 20-32 "Mine/Countermine Operations At Company Level," (1976), FM 90-7 "Obstacles" (1977), and FM 71-1 "Tank and Mechanized Infantry Company Team" (1977). Those sections of the Field Manuals regarding countermine operations require revision to meet the tempo of modern warfare.

FM 20-32 and FM 71-1 advocate the use of time-consuming, antiquated mine locating methods. They describe the use of the hand-held probe, the bayonet, and the hand-held electronic mine detector (AN/PSS-11, Metallic; AN/PRS/7 Metallic and Non-Metallic) which is to be used by a soldier while walking or even crawling. FM 20-32 states that separate mine-clearing teams, also walking, will be brought up to clear or dispose of those mines which were located and marked. The accelerated pace of combat on the modern battlefield simply will not permit these prolonged, laborious mine-clearing techniques.

Mobility and firepower proved to be decisive factors in wars of the past and will be of even greater importance on the modern battlefield. World War II was characterized by the use of large-scale operations over expansive areas and major units at Army and Corps level were employed. World War II combat forces attempted to gain mobility and employ full firepower against their enemies. However, history has shown that even after meticulous planning and coordination, skilled employement of highly improved weapons and equipment, and the brilliant application of sound doctrine, a battle was often lost because the enemy used a seemingly insignificant weapon to gain the advantage -- landmines.

Tactical mobility and firepower will again be decisive principles during the next war. Battles will be highly intense and conducted over a wide area as each side attempts to maneuver and employ full firepower. That commander who gains and retains tactical mobility, denies mobility to the opposing commander, and fully applies all elements of his own firepower will win the battle. Landmine and countermine wareface will be of critical importance to implement both of these principles.

After reviewing the data contained in the main body of this report, six essential characteristics for a countermining system were identified. The rationale which served as a basis for these characteristics is discussed in Section VI, CONCLUSIONS. The six characteristics are as follows:

(1) Countermining devices must be integrated into a "systems's structure." In this sense, a countermining system comprises the functions of mine detection, communication of the hazard, and mine neutralization.

(2) Combat vehicles that are used to breach minefields should be able to fight while they are clearing mines. (Many enemy minefields will be covered by direct fire.)

(3) A high percentage of all combat vehicles, including tanks, armored personnel carriers, and infantry or cavalry fighting vehicles, should be equipped with countermining systems. (An insufficient number of lanes through a minefield can lead to the piecemeal committment of forces.)

(4) Countermining systems should be available for non-combat support vehicles operating in rear areas. (Disruption of rear-area operations is an objective of potential adversaries.)

(5) Countermining systems must be able to neutralize both anti-armor and anti-personnel mines.

(6) Countermining systems must be effective against mines using anti-disturbance, pressure-activated, and magnetic-influence fuzes.

At this time, a combination of VEMASID, rollers and SLUFAE appears to offer the basic elements in a countermining system capable of satisfying the above-listed needs. VEMASID (Vehicle Magnetic Signature Duplicator) is a countermining device currently in development. This device, mounted on a vehicle, projects its magnetic signature ahead of the vehicle. This causes premature detonation of magnetic-influence-fuzed mines. SLUFAE uses rocket-delivered, fuel-air explosives to neutralize pressure-activated mines over wide areas.

A thorough analysis of roller requirements should be conducted. For example, trucks and other non-combat vehicles should be protected against the random mines that are likely to be emplaced on roads. These vehicles certainly require a different type of roller than that used by tracked vehicles operating in cross-country terrain.

It has also been concluded that serious consideration be given to the establishment of a Landmine Warfare School. The purpose of this school would be to prepare and teach mine and countermine warfare, tactics, doctrine, and techniques, and to provide a central location for the development of requirements in mining and countermining systems. U.S. forces are neither properly trained nor equipped to conduct countermining operations. A Landmine Warfare School is needed to focus attention on these problems, and ultimately to solve them.

The Soviets and their Warsaw Pact allies are by no means alone in their capability to use landmines in a future conflict. High-quality landmines are now readily available on the international weapons market, and they will inevitably proliferate throughout the world. The U.S. Army must therefore be prepared to wage countermine warfare at any time and location on the globe.

SECTION II

HISTORICAL SUMMARY

A. INTRODUCTION

This section provides a historical summary of specific battles and campaigns of World War II in which mine and countermine warfare was vital. The purpose of the summary is to determine how and why landmines were used, and the conditions under which their use proved successful or failed. In some instances mines were used to gain tactical advantage on the battlefield and illustrated trends for future mine warfare. In other battles, mines were not employed or were used in lesser quantities; in these cases it is reasonable to speculate what the battle results might have been if mines had been extensively employed.

World War II trends and techniques in countermine warfare are also addressed in this section.

As the effectiveness of mine warfare increased, there was not a corresponding improvement in countermining operations. The British developed flails or chains mounted on rollers fitted to the front of tanks ("Scorpions") to beat paths through known minefields. The allies experimented with and fielded other mine-clearing devices to include demolition snakes, boxed explosives, "bangalore torpedos," spigot mortars, large free-wheeling rollers, and rollers mounted on tanks, trucks, and bulldozers. (In nearly all instances, minefields were "discovered" by chance -- when a soldier or a vehicle encountered a mine and it detonated and produced casualties.) However, the primary and most common method of clearing a path through a minefield was the use of soldiers with bayonets or other probes to locate and remove mines.

Although mining and countermining technologies have advanced since World War II, there is no evidence that the gap between their relative effectiveness on the battlefield has been reduced.

B. 1939-1940, POLAND AND FRANCE

World War II began at 0445 hours on 1 September 1939 with the German invasion of Poland. The Germans employed 44 divisions and 2000 aircraft to defeat 30 first-line divisions, 10 reserve divisions, and 11 cavalry brigades of the Polish military force. Though the Poles fought valiantly -- in one instance a Polish cavalry unit charged an advancing German Panzer unit with drawn sabres[1] -- their forces were quickly defeated. Their defeat can be attributed to the overwhelming size and surprise of the German attack, and the inadequate firepower and obsolete equipment used by the Poles.

Only a limited number of modern tanks and very few up-to-date armored combat vehicles were available to the Polish military force. Of those weapons and combat vehicles that were available, nearly all of them were of World War I vintage and were no match for the modern rapidly maneuvering German equipment.

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[1] Major General F.W. von Mellenthin, "Panzier Battles", Cassel & Company Ltd, London, 1955, page 3.

During the early hours of the invasion, the Luftwaffe conducted heavy bombing raids to destroy lines of communication, supply areas, and mobilization centers. Though the Poles had a large military force, they were unable to bring their numerical strength into action against the well coordinated German attack. The Poles further suffered from insufficient training, but their greatest failure was in their total lack of appreciation of concentrated firepower on the battlefield. They dispersed their forces, ignored the principle of mass, and attempted to defend a frontier of approximately 800 miles from Lithuania to the Carpathians. It must also be noted that the Polish high command did not employ mines at any point along their frontier and expressed no interest in obtaining mines from their French or British allies.

On 10 May 1940 the German military forces attacked again and crossed the borders of France, Belgium, Holland, and Luxembourg. During this attack the Germans exploited two principles of war: surprise and concentration.[2] In their effort to oppose the German Panzer attacks the French made the same tactical errors that the Poles had made; they committed their armor piecemeal in repeated attempts to counter German attacks. The French suffered defeat in detail.

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2 Major General F.W. von Mellenthin, "Panzer Battles", Cassel & Company Ltd, London 1955, p. 12

The German forces were outnumbered by the allies (French, Dutch, Belgian, and English) in both numbers of divisions and tanks. The Germans employed 2,800 tanks while the allies employed approximately 4,000 tanks. The allied tanks were superior in armor thickness and gun size. The subsequent German victory is attributed to their use of combined arms tactics with massed armor, closely supported by motorized infantry and artillery. In addition, there was successful coordination between the Luftwaffe and ground operations.[3]

Mobility played an important role during the German victories. The allied troups were often out-maneuvered and subsequently surprised by new German attacks in unexpected areas. In repeated instances, the rapid movement and flexibility of German Panzer units confused the enemy.[4] Further credit for the German victory is attributed to Panzer divisions which fought as a balanced force of all arms.[5]

Recognition must also be given to the German intelligence effort. The French defensive positions were known in detail to the Germans due to extensive reconnaissance and intelligence effort. Precise details of the French positions were known, including the exact location of individual bunkers.

On 22 June 1940 and 24 June 1940 the French military forces surrendered to the Germans.

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[3] Major General F.W. von Mellenthin, "Panzer Battles", Cassel & Company Ltd, London 1955, p. 13

[4] Ibid, p. 24

[5] Ibid. p. 24

It is interesting to note that at no time during this battle is there any indication that mines were used in an effort to delay or disrupt the German advance or to restrict the rapid movement of German forces into allied countries. This is even more interesting when considering that the military leaders of France, England, and Holland were aware of German tactics and their predictable use of massive, clearly defined armor attacks during their invasion of Poland just eight months prior to the invasion of France.

The German attack on both Poland and France was characterized by a high degree of mobility and their rapid concentration of forces to achieve significant penetrations in the enemy's defenses. The Germans also retained their initiative and dominated the battlefield. Though recognizing the importance of their own mobility, the allies failed to recognize the tactical importance of German mobility. Thus, the allies failed to constrict or limit German mobility and were content in their efforts to engage German forces with conventional gunfire. This was a tactical error. The Germans continued to attack with their concentrated forces in the least suspected areas and were highly successful. If the Polish and/or French forces had employed land mines, even small numbers of them on critical routes, they might have delayed or disrupted portions of the German attack. As a direct result of these delays, the allies might have gained time to concentrate their own larger forces and even conduct counterattacks. Furthermore, the allies could have employed their superior firepower against the exposed and halted German units.

The Soviets were well aware of events in Western Europe during the early days of the war and may have then resolved that mines could have played a vital role in the allied defenses. In any event, the Soviets introduced innovations in mine warfare during subsequent battles in Eastern Europe. (The Soviets were later regarded as experts in mine warfare during the Battle of Kursk and the ensuing battles of Eastern Europe.)

C. NORTH AFRICA

The campaign in North Africa began on 10 June 1940 and ended in May 1943. The initial fighting was between British and Italian forces with the German forces, the Deutsches Afrika Korps (DAK), entering the conflict in February 1941 under the command of General Erwin Rommel. Additional British units landed in the French areas of Northwest Africa in November 1942 to join the battles of North Africa.

The first part of the North African Campaign was conducted with some mines being used in 1940 and 1941. The first mine encounter was by the British at Sidi Azeiz, June 1940, during their attack on the Italian positions.[6] The British attempted to conduct a classic light tank frontal attack with armored cars attacking the flanks. The operation was a disaster. The entire British squadron ran into a hidden minefield and three tanks were destroyed immediately and the other vehicles were immobilized for approximately three hours while trying to move out of the minefield. Thus, a well planned attack was defeated by the simple use of mines.

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[6] Herchal Ottinger, "Landmine and Countermine Warfare, North Africa", Department of the Army, Office, Chief of Engineers, Washington, D.C. 1972, page 9.

The use of mines and countermine warfare rapidly escalated during the campaigns in North Africa. The lessons learned during these encounters significantly changed the doctrine and tactics used by the combined arms team of Armor and Infantry. Initially, tanks led the way for an attack. However, by June 1942, with huge minefields being emplaced (see Figure 1), it become doctrine to lead an attack with minesweepers to clear paths for armor and infantry units.

Mines were extensively used by the British and the Germans to deny mobility, restrict access on avenues of approach, provide barriers and obstacles for defensive positions, and to act as combat multipliers for direct and indirect weapons fire. At Ain El Gazala, near Tobruck, the British emplaced more than one million mines in two months. They also constructed interconnecting minefields having a depth of several thousand yards.[7] During the British defense of El Alamein during August 1942, approximately 150,000 mines were emplaced to support the defensive positions.

The Germans, near El Alamein in October 1942, employed more than 500,000[8] mines to support their defensive positions and deny the British avenues of approach over roads or open desert (see Figure 2). It is interesting to note that many of the mines used by the Germans were captured British mines that were relocated and used in the German defenses.[9]

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7 Rommel Papers, page 457.

8 Rommel Papers, page 276.

9 Dr. Russel H. Stolfi, "Mine/Countermine Warfare, in Recent History, 1914-1970", BRL Report 1582, Aberdeen Proving Ground, Md, 1972, page 50.

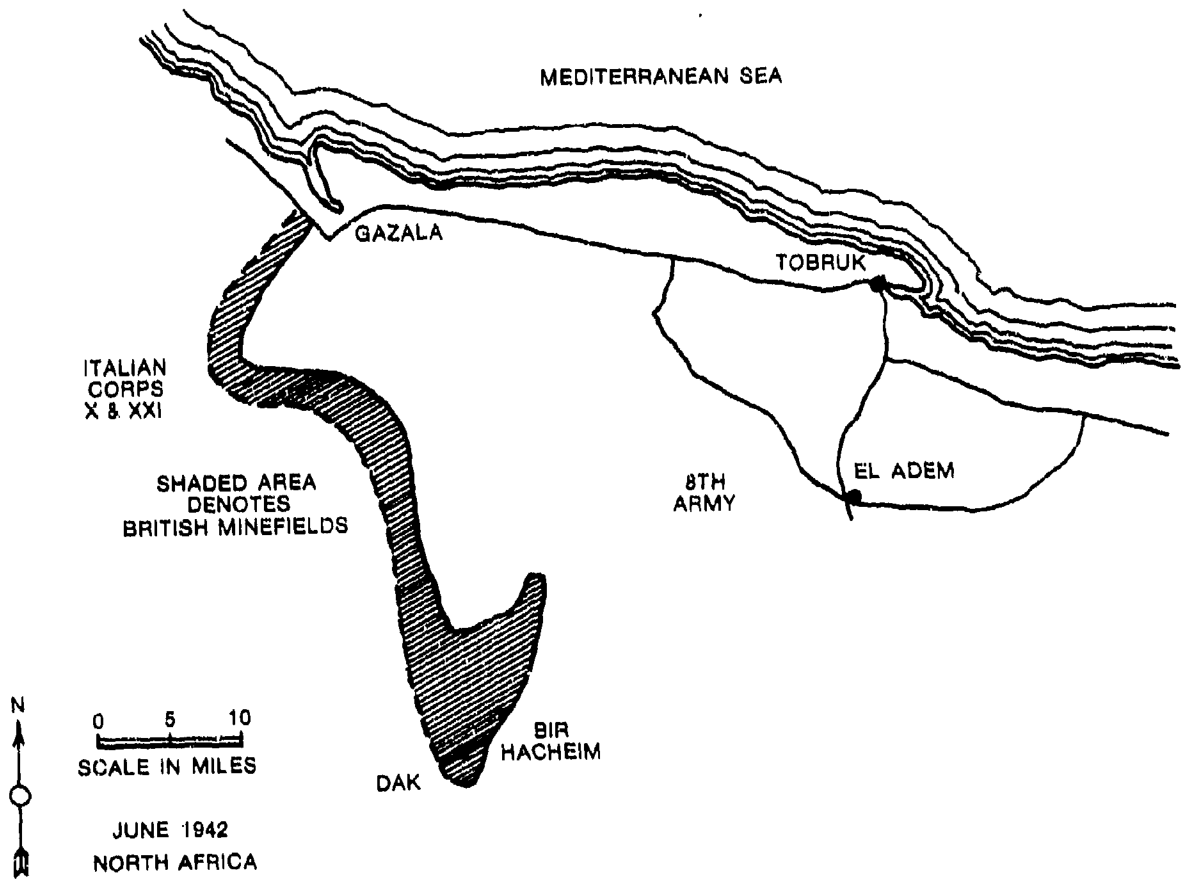

Figure 1. Extensive British Minefields Near Tobruk

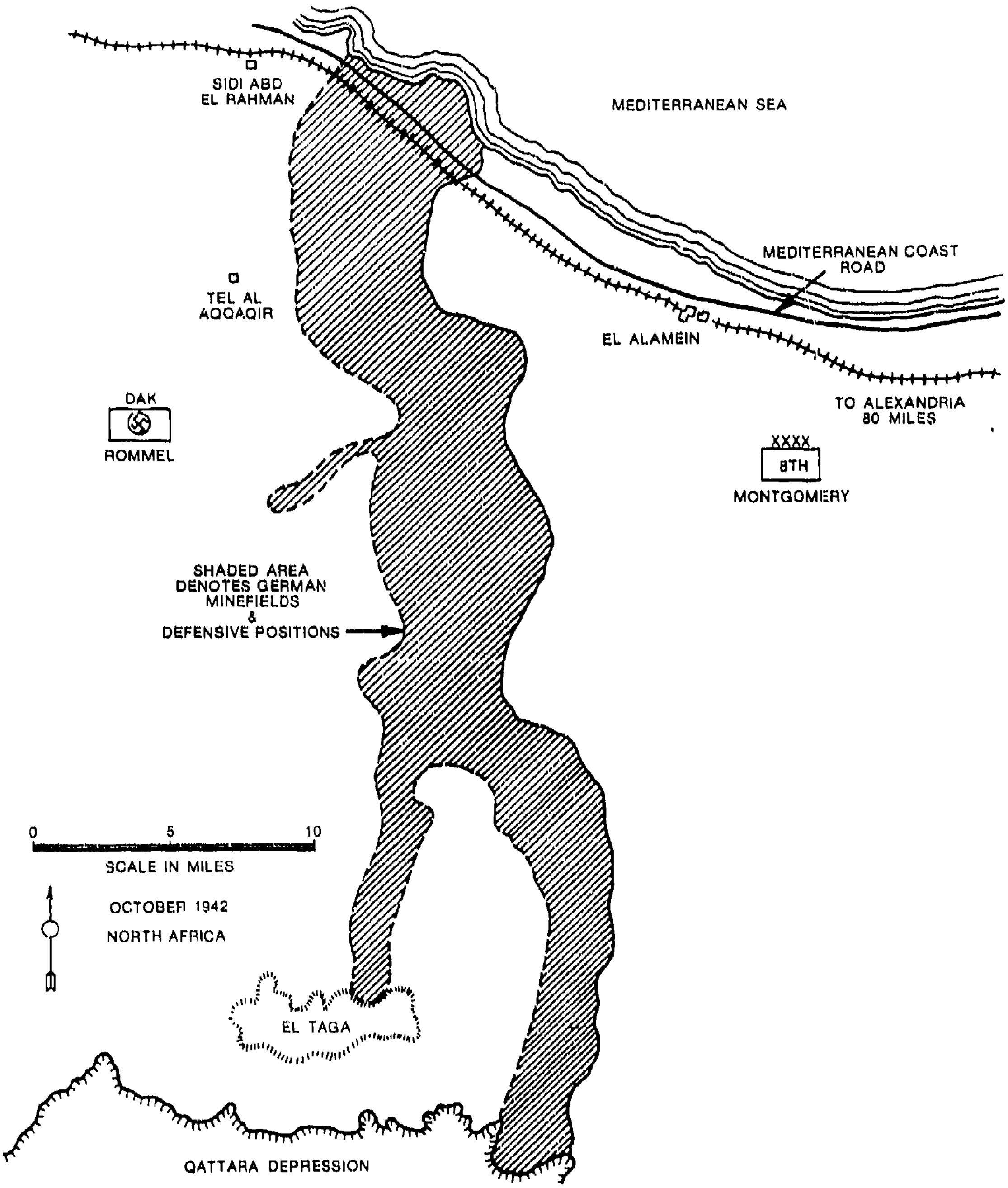

Figure 2. German Minefields Near El Alamein

Field Marshall Rommel and the allied commanders simultaneously recognized the tactical value of mines following German encirclement of Tobruk in April 1941. Rommel's Afrika Korps was repeatedly delayed by extensive British minefields, and German attacks on well fortified positions with dense perimeter minefields were slowed, disrupted, and often defeated. It was during these combat engagements that Field Marshall Rommel gained his insights regarding mine and countermine warfare.[10]

During the period 5 and 6 January 1941 in North Africa, the Italians applied one of the most innovative and original concepts in mine warfare. The Italians developed the air-delivered "thermos bombs" or small bomb-mines which resembled thermos flasks and contained about four pounds of explosive and a fuze. Many of these mines were dropped behind the Australian lines at Bardia and on the Australian Group Headquarters to disrupt and destroy command and control elemen ts, delay supply movement, disrupt communications, and cause chaos within rear areas. The "thermos mines" were dropped by aircraft and the shock of hitting the ground armed the mine so that it would explode when touched, run over, or disturbed.

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[10] Major K. J. Macksey, "Afrika Korps", Ballantine's Illustrated History of World War II, Ballantine Books Inc., New York, 1968.

This Italian concept was unique in several ways: the mines were air-delivered; the mines were remotely emplaced; the mines were dropped to the <u>rear</u> of forward combat elements and on rear area headquarters; and the mines caused psychological effects by detonating against an unsuspecting targets operating in a relatively "safe" rear area.[11]

The powerful German Teller anti-tank mines were widely used and proved to be highly effective against all of the British tanks (Crusader, Stuart, Valentine, and Matilda). In June 1941, the British organized and launched their major attack, "Operation Battleaxe" against the much inferior German force. This attack was defeated by the strong mobile defense prepared by elements of the Afrika Korps. The Germans used the deadly 88mm gun operating from gun positions with a 360° field of fire. The Germans also emplaced large quantities of anti-tank and anti-personnel mines on each possible avenue of approach. As the British approached they were delayed by the minefields, some vehicles were destroyed, and their attack was disrupted. The German gunners used their 88's to engage and destroy the slowly moving or halted British tanks and combat vehicles. The British attack was totally defeated.

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[11] "Landmine and Countermine Warfare, North Africa, 1940-1943", Engineer Agency for Resources Inventories, Washington, D.C. 1972, page 30.

The campaign in North Africa continued from June 1940 through February 1943. During that time both the Germans and the British protected their defensive positions with extensive minefields based on their recently acquired knowledge of mine warfare and its tactical significance. Each side also prepared for new offensive operations. Both sides recognized that mines had become the most important weapon to deny or restrict enemy maneuver and thus limit the employment of enemy firepower.

U.S. operations in Tunisia during January 1943 proved that both AT and AP mines were essential munitions and were not just barrier or obtacle materials. General Leslie J. McNair of the U.S. Army stated that, "the land mine represented almost a new form of warfare," after his visit to North Africa following the Allied victory in May 1943.[12]

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[12] "The Ordnance Department; Planning Munitions for War", U.S. Army Chief of Military History, Washington, D.C. 1955, page 381.

At one point in the North African campaign the British concluded that the most vital preparation for battle was the requirement to clear enemy minefields.[13] This may have been in response to Field Marshal Rommel's defense of El Alamein with "Devil's Gardens." Rommel directed that El Alamein be defended with huge fields of great defensive strength which he called "Devil's Gardens." These were large, complex minefields placed in horseshoe patterns and made up of multiple mine types, 250-pound Luftwaffe bombs, hand grenades, captured artillery ammunition, and various other explosives. All were armed with multiple fuzes. German engineers and sappers worked day and night and often emplaced more than one thousand mines per night.[14]

The result was a dense, well prepared minefield that surrounded and linked the German positions to a depth, in some places, of four miles. The minefields were covered with direct and indirect weapons fire.

During offensive engagements, both the British and Germans implemented the tactic of securing a recently captured position by quickly emplacing mines to prevent a successful counterattack. Avenues of approach and key roads leading to the newly occupied area were quickly mined.

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13 Major K. J. Macksey, "Afrika Korps", Ballantine's Illustrated History of World War II, Ballantine Books Inc., New York, 1968.

14 "Landmine and Countermine Warfare, North Africa, 1940-1943", Appendixes, Engineer Agency for Resources Inventories, Washington, D.C. 1972, page J-2.

Concurrently, efforts on both sides were directed to the development and fielding of mine-clearing devices. This resulted in the Scorpion tank, developed by the British, which were Matilda and Valentine tanks fitted with heavy chain flails. As a front-mounted drum rotated, the chains were thrust forward to strike the ground and detonate any mines that might be present. Other mine-clearing devices included heavy rollers mounted on tanks and trucks, extended rollers also mounted on vehicles, and the use of dismounted infantry and sappers who moved into minefields to clear paths by hand.

A major weakness of some German minefields was that they did not contain sufficient numbers of anti-personnel mines. They could be quickly cleared by infantry and sappers who entered the anti-tank minefields and removed or defuzed the mines. This was particularly true at El Alamein where the Germans used only three percent anti-personnel mines in their defense. This led to another vital lesson learned by both sides regarding mine and countermine warfare; an anti-tank minefield must also contain anti-personnel mines to prevent sappers from entering the minefield with impunity and defuzing anti-tank mines to open paths of safe lanes toward an attack objective. Moreover, it was a common occurance for both the British and the Germans to send sappers into a minefield during the night (and sometimes during daylight) to remove mines and clear a path or lane -- and actually remove enemy anti-tank mines for their own subsequent use.

In other instances, the British forces sent sapper teams into German anti-tank minefields that were not protected or reinforced with anti-personnel mines for the purpose of moving mines to clear paths, and then relocating the mines. The pattern of the German-emplaced minefield was thus changd and converted to the tactical advantage of the British.

Reports following the North African Campaign illustrate that a minimum of 18 percent of the allies tank losses are directly attributed to mines.

Some of the important lessons learned in North Africa are listed below:

- o Mines can be effectively employed during both offensive and defensive engagements.
- o In addition to their own kills, mines increase the exposure time of vehicles and personnel to direct and indirect fire weapons.
- o When minefields are employed, they should be covered by direct and indirect fire weapons to be fully effective in delaying and destroying enemy vehicles and personnel.
- o Mines need not be always concealed or buried to delay or disrupt enemy maneuver, but minefield effectiveness is enhanced by the element of surprise when mines are unexpectedly "discovered" (through detonation) by the enemy.
- o It is feasible and practical to emplace large minefields, 5 to 7 miles deep and up to 30 miles wide, to improve defensive positions.
- o Countermine equipment and capabilities must be immediately available to a maneuvering combat force.

- o Countermining equipment must be sufficiently mobile to maintain the speed of an attack and equal the speed and mobility of the maneuver force.

- o Minefields must contain a mix of anti-tank (AT) and anti-personnel (AP) mines.

- o Mines add to the defender's advantage by delaying movement and lengthening battles.

- o The British recognized that some mined areas had to be rapidly cleared to make way for their armor. Hence they introduced the use of flails. Nonetheless, the urgency of quickly clearing paths through minefields was probably not appreciated. Manual clearing could be accomplished in darkness -- night vision equipment was not available during this era -- and many minefields were not adequately covered by fire. Recognition of the latter weakness produced mixed AT/AP minefields, which in turn presented one more hazard to the already slow manual mine-clearing operations.

D. ITALY

The campaign in Italy was characterized by a German retrograde operation as they moved north. The Germans selected key defensive positions along the routes of withdrawal and protected them with direct- and indirect-fire and large quantities of well placed mines. These efforts often delayed allied attempts to pursue and engage their retreating forces. German tactics and the skillful use of mines permitted a successful retrograde movement and avoided a decisive engagement.

German Field Marshal Albert Kesselring conducted a classic delay operation through southern Italy from Salerno. Though he had only a limited number of troops, he employed his personnel, weapons, and mines to maximum advantage. Again, landmines and demolitions were used to supplement marginal forces and weapons, and they proved to be combat multipliers in the face of adverse odds.

In late January 1944 the Allied army began the attack against German defensive positions in the City of Cassino and the Benedictine Abbey at Monte Cassino. In this area German engineers had diverted the Rapido River and flooded the flat area in the vicinity of the Allied approach. This significantly reduced Allied mobility, delayed the preparations for the attack, and provided additional time for the Germans to prepare their defenses. Numerous attempts to establish engineer bridgeheads over the Rapido River failed because of the extensive German emplacement of mines, accurate gunfire, and blown bridges. The Germans used large numbers of wood anti-tank Holzmine, clay or "Pot Mines," and wood anti-personnel Schumine which were highly effective and avoided detection by conventional electronic mine detectors. In one instance, U.S. soldiers drove a herd of sheep along the river bank to detonate a suspected AT and AP minefield.[15]

It is evident that the Germans had profited from their experience with mines in North Africa. In Italy, they exploited mines to blunt Allied attacks and help prevent a decisive engagement which might have resulted in German forces being routed.

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15 "Landmine and Countermine Warfare, Italy 1943-1944", Appendixes, Engineer Agency for Resources Inventories, Washington, D.C. 1972, page B-8.

It is also apparent that mine-clearing techniques and operations were not keeping pace with mining activities. Countermining was still slow and difficult, and seriously delayed the Allied advance.

E. RUSSIA

During the summer of 1939 Adolf Hitler remarked to his military leaders and General Staff that he intended Russia to suffer the same fate as Poland. He announced his intention and plan to invade and destroy Russia during the summer of 1941.

On 18 December 1940 Hitler issued his first formal directive for the invasion of Russia, Operation Barbarossa. The German offensive against the Soviet forces began on 22 June 1941 and started a campaign that would last for four years, from June 1941 to May 1945.

The Russian portion of WW II is divided into four separate phases:

o German invasion of the Soviet Union	-	Summer Offensive	June 1941
o Stalingrad Campaign	-	Summer Offensive	1942
o Soviet Offensive in Western Russia	-	Summer Offensive	1943
o Soviet Liberation of Eastern Europe	-	Summer Offensive	1944

The Germans initiated their attack across the Soviet border at 0300 hrs 22 June 1941. Complete tactical surprise was achieved. By the end of the first day, advances of six or seven miles were attained all along the front, and gaps were designated and opened for German Panzer divisions to start their exploitation. During the first ten days the Germans advanced over 200 miles into Russia to Minsk and captured 323,000 prisoners, 3,200 tanks, and 3,200 artillery pieces.[16]

Though the Germans had outstanding initial success, the Soviet military force had mobilized and began effective resistance to the German invasion of Russia. Concurrently, German supply lines were extended to the maximum and Soviet counterattacks improved. In December 1942 the German Wehrmact had been stopped at Moscow, and the Soviets launched their winter counter-offensive of 1942.

The Soviets produced large quantities of weapons during the initial stages of the war, but beginning in 1943 their production rate increased. This included thousands of landmines which were used to protect Russian defensive positions. In addition, mines were used in Russian offensive operations to preclude German counterattacks and to deny German flank attacks.[17] By 1942 the fortifications of

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16 "Landmine and Countermine Warfare, Eastern Europe", Engineer Agency for Resources Inventories, Washington, D.C. 1973, page 15.

17 U.S. Army FM 23-3, "Techniques of Antitank Warfare" Headquarters, Department of the Army, August 1966, page 151.

Sevastopol had been strengthened and modernized to include new weapons, anti-tank ditches, and 137,000 anti-tank mines.[18] However, following a determined attack, German forces seized and occupied the city on 2 July 1942.

The Soviet offensive began on 19 November 1942 and major Soviet attacks resulted in significant losses for both sides. However, German losses of men and material could not be replaced as they were for the Soviets.

The initial battle of Kursk was the German offensive against that city. This battle was known as "Fall Zitadelle" by the Germans, or "The Battle of Kursk" by the Russians. The City of Kursk is on the low plateau of Central Russia and is 330 miles south of Moscow where the Tuskor and Seym Rivers meet. The German offensive against Kursk began at 0220 hrs 5 July 1943 after repeated delays by the German High Command. Soviet intelligence had predicted the attack and provided time for them to prepare and even rehearse their defensive actions. The Russians moved large additional troop units, material, and tanks and guns to Kursk. In addition, their defensive positions included large quantities of anti-tank and anti-personnel mines. Total strength figures for each side in this massive battle were as follows:[19]

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18 "Landmine and Countermine Warfare, Eastern Europe", Engineer Agency for Resources Inventories, Washington, D.C. 1973, page 23.

19 "Kursk", Ballantines Illustrated History of World War II, Book #7, Geoffrey Jukes, Ballantine Books, Inc., New York, 1969, pages 78 and 79.

	Wehrmacht	Red Army
Troops	900,000	1,337,000
Artillery Pieces	10,000	20,220
Tanks & Assault Guns	2,700	3,300
Aircraft	2,500	2,650

The Russians used strong, multiple defensive belts, fortified positions, and anti-tank and anti-personnel minefields containing a density of over 4,000 mines per mile.[20]

The decisive factors of the Battle of Kursk were landmines and firepower. The advancing Germans' guns had not been able to engage and saturate the forward Soviet defensive area or gun positions, and had not been able to clear paths through the extensive minefields. The German advance was delayed, disrupted and destroyed by a combination of Russian mines, gunfire, and counterattacks. Many German tanks were disabled by mines in the first half mile of the assault and were overtaken by the supporting German infantry.

The Russians also developed a strategy which the Germans called a "pakfront": groups of up to ten guns would concentrate on a single target at one time.[21] These groups were organized in depth in the defended area. Minefields had been

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20 "Landmine and Countermine Warfare, Eastern Europe", Engineer Agency for Resources Inventories, Washington, D.C. 1973, page 26.

21 U.S. Army FM 23-3, "Techniques of Antitank Warfare", Headquarters, Department of the Army, Washington, D.C. August 1966, page 153.

emplaced to channel attacking tanks into the fields of fire of the AT guns or "pakfronts." These deadly traps were placed to depths extending over five miles.

In less than three weeks the last major German offensive in Eastern Europe had been stopped and forced back by the determined Russian forces. History regards the Battle of Kursk as the greatest tank battle of all time. In establishing their defenses and preparing for immediate counterattacks the Soviets observed several principles of mine warfare:

- Emplace large, dense minefields in conjunction with natural obstacles and barriers.

- Cover all minefields with direct and/or indirect fire.

- Mass artillery fires on preplanned areas and avenues of approach where extensive minefields have been emplaced.

- Employ mines by type (AP and/or AT) based on the terrain and enemy threat.

As the war in Russia progressed during 1942-1943, Soviet mine warfare continuously improved. Soviet planning; mine types; tactical employment; countermeasures; and actual mine emplacement was developed to a fine art by their Army. The combat power of <u>each</u> Soviet position and unit area was improved by the extensive use of mines. They generally employed a belt of mines approximately 10 yards in front of the most forward Soviet position. Possible avenues of approach and any route, road, or trail leading into a Soviet position or possible enemy counterattack route were heavily mined with both AT and AP mines. Mines were left behind and on rail tracks as the Soviets withdrew.

Mines were often emplaced even while under fire because they were deemed to be that important to the Soviets. Extra mines and explosive charges were often emplaced to be visible and easily discovered. The detection and removal of these charges was intended to provide the enemy with a false sense of security and subsequently increase the effectiveness of the remaining mines. They made extensive use of wood to fabricate mines which could not be detected by mine detectors.

Dedicated transportation to ship mines to the battle area was often not available to the Soviets. Therefore, each man who was moving to the front as a replacement was ordered to carry a minimum of two anti-tank mines in addition to his regular equipment. At the front, these mines were emplaced by engineers in accord with a precise mine warfare plan. In the southern Ukrain 20,000 mines were emplaced in one day.[22]

The Soviets were particularly interested in mining German rear areas. The delay and detonation time was varied and mines were often placed in pairs to ensure detonation, and to force the Germans to constantly make repairs and be continually harassed by unexpected delays caused by explosions.

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22 "Landmine and Countermine Warfare, Eastern Europe", Engineer Agency for Resources Inventories, Washington, D.C. 1973, page 30.

When the Germans seized and occupied Kiev and Vyborg in 1941, and Sevastopol in 1942, they found the cities heavily mined with Russian radio-controlled mines. The Russians then began to remotely detonate the mines as the Germans entered the cities. These mines were compact, easy to transport and conceal, had built-in safety devices to preclude accidental detonation, and had special timing and firing mechanisms that permitted their detonation only when a specific code was transmitted at a given speed.[23] This attests to the Soviet state of the art in mine technology in 1942.

As the tide of battle turned against the Germans, the Soviets themselves encountered minefields. And, like the Germans, they found mine-clearing to be far more difficult than mine emplacement. In one reported instance, the Russians cleared a German minefield by marching soldiers over and through the minefield to detonate mines.[24] The soldiers were aligned shoulder to shoulder and then marched through the minefield. They faced certain death by pistol or rifle fire if they resisted the lesser risk of stepping on a mine during the course of their march.

The war in Russia demonstrated the Soviet predilection for massive, defensive minefields. The Soviets report that they used 222 million mines during World War II.[27] They also recognized their countermining deficiencies, as evidenced by the countermining equipment they introduced in the 1950s. (This equipment is discussed in Section III.)

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23 "Peculiarities of Russian Warfare", German Report Series MS # T-22, Department of the Army Historical Division, 1949, page 46. (Office of the Center of Military History, Washington, D.C.)

24 Ibid.

25 "Landmine and Countermine Warfare -- Eastern Europe", page 1 (Engineering Agency for Resources Inventories, Washington, D.C.).

F. NORMANDY

The Germans planned and organized large scale defensive plans along the French Atlantic Coast and on the Normandy Beaches in anticipation of an allied invasion of Europe. The Germans recognized the possibility of such an invasion and began their plans in 1943. However, they did not know where or when an invasion could be launched. This was due in part to numerous allied efforts to deny the Germans any information regarding the invasion, and counter-intelligence efforts designed to deceive the German High Command and intelligence network. History could have been significantly different if all of the German counter-invasion plans had been fully implemented.

Two major German commanders envisioned two separate plans for the Atlantic Defenses. Field Marsh Gerd von Rundstedt wanted to place mobile reserves composed of Panzer and Panzergrenadier divisions inland. Then, after the strength, direction, and intent of an allied invasion was determined, the German force would move to engage and destroy the allied force in a counterattack. Field Marshal Erwin Rommel, who directed the German coastal defenses from the borders of Spain to Denmark, was in the process of building a huge defensive network to halt any invasion on the beach. He advocated that all available German troops be positioned to immediately destroy and stop an invasion and prevent an allied force from establishing a beachhead.[26,27,28]

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26 "The Rommel Papers", Edited by B. H. Liddell Hart, Harcourt, Brace & Company, New York, 1953, page 458.

27 Desmond Young, "Rommel the Desert Fox", Berkley Publishing Corp., New York, 1950, pages 166-189.

28 R. W. Thompson, "D-Day Spearhead of Invasion", Ballantine's Illustrated History of the Violent Century, Ballantine Books Inc., New York 1968, page 60.

The ultimate task for the German High Command was to defend a coast line in excess of 3,000 miles with just 59 lesser class divisions. Only ten of these divisions were armored. In February and April 1944 Field Marshal Romel issued a directive to his army commanders. Portions of that directive are quoted as follows:[29]

> "In the short time left before the great offensive starts, we must succeed in bringing all defenses to such a standard that they will hold up against the strongest attacks. Never in history was there a defense of such an extent with such an obstacle as the sea. The enemy must be annihilated before he reaches our main battlefield. We must stop him in the water, not only delaying him but destroying all his equipment while it is still afloat."

Rommel repeatedly emphasized to his commanders and staff that the first twenty-four hours of an invasion would be decisive. He emphasized that all efforts must be made to construct in-depth defenses fabricated from all possible materials, that extensive lethal minefields must be emplaced, and that all barriers and obstacles must be covered by direct and indirect weapons fire.

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29 Ibid, page 60.

Adolf Hitler did not fully support either the plan of Rommel or von Runstedt but had a plan of his own. Eventually elements of all three plans were incorporated into the German Atlantic Defense plan. However, vital elements of Rommel's plan were not included. Rommel did not receive the weapons, ammunition, troops, nor mines that he had requested. Von Rundstedt did not receive the mobile reserve and troops that he had requested. Yet history shows that the final defensive plan, particularly the Normandy area, during June 1944, almost succeeded.

Field Marshal Rommel, while remembering his highly successful use of mines in North Africa and the success of British mines used against him, called for 100,000,000 mines to be used in the defense of the French Coast.[30] These mines and barriers were to be emplaced by German infantry and engineer units. The mines were to be used in conjunction with fortifications, gun positions, tank traps, and steel and concrete barriers to destroy and delay the attempted invasion. The final defense was an extensive barrier consisting of various highly ingenious and multiple obstacles. The essential element of the entire concept was landmines.

[30] Doctor Russel H. Stolfi, "Mine and Countermine Warfare in Recent History, 1914-1970", BRL Report #1582, Ballistic Research Laboratories, Aberdeen Proving Ground, Maryland, 1972, page 71.

Rommel did not receive the millions of mines which he had requested. The actual number finally emplaced was only five to six million mines, largely emplaced along the French Atlantic and Channel Coast. On Omaha Beach alone, Rommel wanted ten million mines to ensure a successful defense, but the division emplacing the mines received only ten thousand anti-personnel mines and no anti-tank mines.[31] "The effectiveness of the German defenses on Omaha Beach can be attributed significantly to the light, but well sited minefields."[32] Movement inland was delayed primarily because of the psychological supremacy of German mines over the American engineers and infantrymen.[33] However, intense fighting, leadership, and the sheer determination used in countermine operations enabled the allies to complete the successful invasion at Normandy and continue the attack into Europe.

Mines continued to play a vital role in the German defenses and significantly contributed to the German delay action as they moved back into Central Europe. Mines were used whenever and wherever possible and accounted for significant losses to allied personnel and equipment. Though direct and indirect fire weapons caused the majority of casualties, it became evident that numerous casualties were sustained because of reduced mobility and prolonged exposure to weapons fire caused by minefields.

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[31] Ibid, page 74.
[32] Ibid, page 75.
[33] Ibid, page 77.

Field Marshal Erwin Rommel's concepts of mine warfare learned in North Africa again proved valid at Normandy. These concepts on mine warfare remain equally valid today.

G. WORLD WAR II MINE WARFARE SCHOOLS AND TRAINING

The preceding synoptic history of World War II landmine warfare leads to two important observations. First, it is evident that there was a rapid evolution of mining tactics and technology. The rate at which these developments took place was undoubtedly influenced by the successful use of mines. The second observation is that countermining measures failed to keep pace with mining developments.

Nearly all of the combatants of World War II began the war with a minimum of mines and mine types -- and even less training and experience in mine warfare. This was soon to change, and mine and countermine schools would be emphasized.

The U.S. military first became aware of the use and effectiveness of mines and mine warfare based on French and British reports (prepared in 1940 and in 1941) citing the German and Allied use of mines during World War I. The U.S. military had primarily depended on British mines and mine technology prior to World War II and had not directed much effort toward mine warfare training or the tactical application of mines. After the second battle of El Alamein and the first American experience with mines in Tunisia, the U.S. Army was seriously concerned with mine warfare and training. Added experience in mine warfare was gained in Italy during the U.S. drive against the retreating German forces. By this time, the Germans had changed their minefield tactics and methods of employment. They discontinued emplacing mines in patterns, increased the use of anti-personnel mines in anti-tank minefields, and used anti-personnel mines forward of all defensive positions. The Germans also made extensive use of anti-personnel mines forward of and to the flanks of each machinegun position. The U.S. Army soon recognized that experience was a costly teacher and that mine warfare training was desparately needed. This lesson was reinforced by U.S. and Allied mine casualty figures reported from North Africa and Italy.

A series of decisions were made among the Allies to establish mine warfare schools. The British First Army mine warfare school opened in February 1943. The existing British engineer school did not include mine warfare. The U.S. Fifth Army engineer school expanded its training program to increase the hours of instruction on mine and countermine warfare. These additional hours and emphasis recognized the basic mission of engineers -- to maintain the mobility of the Fifth Army -- and the German efforts to deny mobility by the use of demolitions and mine warfare. The Germans had been successful in their efforts, and additional U.S. engineer countermine training became essential to overcome the German mine warfare capability. Allied mine warfare training was eventually escalated to Theater Level to disseminate mine and countermine warfare knowledge among the Allied forces.

A mine and countermine school with a similar curriculum and emphasis does not exist within the U.S. Army or military school and training system today. U.S. Army Field Manuals, FM 71-1, FM 71-2, FM 90-7, FM 100-5, and FM 20-32, define and explain the concepts of mine and countermine warfare, and Army Training and Evaluation Program (ARTEP) 71-2 for the Mechanized Infantry/Tank Task Force (June 1977) prescribes the tasks, conditions, and standards for mine emplacement, mine removal techniques, and fundamental doctrine. However, these essential subjects are not formally presented at the U.S. Army Service School level.

Regretably, the U.S. Army's interest in countermine warfare apparently reached its zenith in World War II. Since that time tactics and technology of mining has continued to make steady progress. There is little evidence that countermining measures have made comparable gains.

SECTION III

SOVIET CAPABILITIES

A. INTRODUCTION

The Soviets learned their lessons well regarding mine and countermine warfare during World War II. They initially learned at considerable cost from their expert instructors, the German Wehrmact, but later began to develop and implement their own innovative and highly effective tactics. Even with the Soviets' employment of massive quantities of tanks, guns, and soldiers, they realized that mines significantly enhanced and multiplied the effects of their combat power against the Germans. And, they learned from bitter experience just how effective German mines were when employed against them. No nation in the course of military history has equaled the Soviets in mine warfare. They have developed and refined mine warfare and will use it regardless of limitations imposed by a rapidly changing tactical situation, supply problems, or enemy activity or superiority.[1]

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[1] Bernard F. Halloran, "Soviet Land Mine Warfare", The Military Engineer, No. 418, March and April 1972, page 115.

As cited in the historical section regarding World War II, the Soviets employed mine warfare at every opportunity to gain tactical advantages. Their experience taught them to employ mines during both offensive and defensive engagements, and that mines are equally effective at the forward edge of the battlefield (FEBA), on avenues of approach, on potential counter-attack routes, bridges and cross-roads, and in enemy rear areas. It is highly probable that the Soviets and their Warsaw Pact allies will employ this same fundamental mine doctrine during any future war. In contrast to World War II, however, the Soviets will employ the doctrine on a much larger scale with highly improved equipment, personnel, and training.

The fact that the Soviet and Warsaw Pact military forces have far exceeded their defensive requirements and have clearly moved to an offensive capability and posture is of primary concern.

B. SOVIET MINE WARFARE

Soviet mine warfare doctrine, training, and equipment emphasizes the use of mines in support of highly mobile offensive maneuvers and defensive operations. This support will be provided by mobile obstacle detachments organic to the motorized rifle regiment and by divisional engineer battalions. These units will be augmented by non-engineer personnel as required.

During offensive engagements the mobile obstacle detachment, or MOD, will perform the following designated missions in support of the primary mission of the regiment or division:

- Flank protection of advancing formations

- Denial of enemy access to critical terrain

- Blocking of potential avenues of approach and counterattack routes

- Securing and blocking bridges and crossroads.

- Delaying and deterrence of enemy movements in rear areas.

Defensive Soviet minefields will be emplaced to accomplish the following:

- Control of the direction of enemy movement.

- Reinforcement of the combat effectiveness of Soviet weapons.

- Canalization of the enemy movement into pre-established killing zones.

- Inflicting personnel and equipment losses.

- Blocking avenues of approach, key bridges, routes, and crossroads.

- Reinforcement of obstacles, barriers, tank traps, and river banks.

- Immediately securing the perimeter of a newly taken objective.

Fundamental Soviet and Warsaw Pact doctrine requires that anti-tank minefields contain 750 to 1000 mines per kilometer of front and be emplaced in multiple belts. The belt at the greatest distance from their front will be within the maximum effective range of the defending anti-tank weapons. When a three-belt minefield is emplaced with each belt having a density of 750 anti-tank mines per kilometer of front, kill probabilities of at least 70% are expected.[2]

Soviet doctrine requires a density of 2000 anti-personnel mines per kilometer of front.[3] Approximately 200 to 400 of these mines will be activated by trip wires. Soviet doctrine further requires that each anti-tank minefield also contain a large number of anti-personnel mines, but the prescribed ratio of anti-tank to anti-personnel mines is unknown. Fundamental Soviet and Warsaw Pact doctrine states that anti-tank and anti-personnel minefields should be emplaced to reinforce natural barriers and obstacles. In addition, all minefields should be covered by both direct and indirect weapons fire if possible.

The Soviets have several means of emplacing mines other than hand-emplacement by individual infantrymen or engineers. For example, the PRM-3 is a towed mechanical minelayer developed in 1960. The PRM-3 has a four man crew: driver, operator, and two feeders. The PRM-3 is usually towed by a modified armored personnel carrier fitted to carry 120 TMN-46 mines in the cargo compartment. A

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[2] James E. Deaton, "The Military Engineer", "Engineering Capabilities of the Soviet and Warsaw Pact Armies", November/December 1979, Issue Number 464, page 421.

[3] Ibid, page 421.

fully loaded vehicle with 120 mines, pulling a planter set to disperse mines at 4 meter intervals, can emplace a 0.5 kilometer mine belt in approximately 15 minutes. Divisional engineer companies have four mine layers, and two additional mine layers are located in the divisional engineer battalion.[4]

In 1968 the Soviets modified the PT-76 light tank to serve as an armored, full-tracked minelayer equipped with mine emplacement devices. It also has a total basic load of approximately 208 mines. The overall height of the vehicle is increased by 24 inches, with another set of drive sprockets being added to power the mine conveyor belt. When operating at a speed of 9 kilometers per hour, the modified PT-76 can emplace a belt of mines 860 meters long in approximately five to eight minutes.[5]

The Soviets have also developed and fielded a helicopter mine-laying system. The helicopter and its equipment are designed to emplace either anti-tank or anti-personnel mines, and can emplace approximately 200 to 250 mines at a rate of 4 mines per minute.[6]

C. SOVIET COUNTERMINE WARFARE

Soviet doctrine, organization, equipment, training, and military philosophy reflects their intense belief in countermine warfare. This is based in part on

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[4] Ibid, page 421.

[5] Ibid, page 421.

[6] "Selected U.S. and Soviet Weapons and Key Equipment", Reference Book (RB) 30-2, U.S. Army Command & General Staff College, Ft. Leavenworth, KS, July 1977, page 77.

their still vivid recollections and lessons learned during World War II and their awareness of current developments in mine warfare capabilities. Therefore, they anticipate and plan for any enemy force to employ extensive minefields against them. Accordingly, they have developed and fielded countermine equipment. It is highly probable that they now have even more capable countermining equipment that has not been observed during routine training exercises.

Current Soviet countermine equipment includes:

- DIM Detector, truck-mounted (UAZ-69 or UAZ-469 trucks) mine detector. The mine detection device is fitted to the truck brakes to stop it automatically when a detection is made.

- Mine Detection Helicopter. The helicopter is fitted with a detection device suspended below the aircraft. The helicopter is flown over a suspected minefield, mines are located, and the pattern of the minefield is plotted and reported for subsequent clearing.

- PT-55 and KMT-5 -- Soviet mine-clearing roller and plow combination fitted to a medium tank (T-55, T-62, T-64, or T-72). Several models of this device are employed by the Soviets. The plows are controlled separately from inside the tank, and rollers are made up of multiple discs of various configurations. A chain is suspended between the two rollers to detonate any tilt-rod fuzed mines. Each platoon of tanks has, as a minimum, at least one mine-clearing tank.

- o BTU Soviet tank dozer. Designated Soviet tanks are modified and equipped with fittings to accept the full-width dozer blade.

- o BTR-50PK Mine Clearer with explosive line charges. This equipment fires a rocket to deploy a flexible tube containing high explosives across a minefield. The tube is then detonated to open a lane through the minefield.

In this unclassified report other known classified Soviet countermine and mine clearing capabilities are not listed or identified. However, it is readily apparent that the Soviet military forces will use extensive quantities of land-mines during offensive and defensive operations, and they have developed and fielded countermining systems to use against enemy minefields.

D. SOVIET ENGINEER ORGANIZATION AND DOCTRINE

Soviet engineers are organized into battalions, regiments, and brigades to provide engineer support to units above division level. Soviet combat engineers, unlike U.S. Army Engineers, do not engage in bridge and road building, map making, and railroad and waterway activity. Their main mission is to assist in maintaining the speed of advance of ground forces across natural and man-made obstacles. Concurrently, they execute mining operations to delay enemy movements and maneuvers.

Engineer elements are included in all reconnaissance formations. Soviet engineer units for Front, Combined Arms Army, and Division are illustrated in Figure 3.

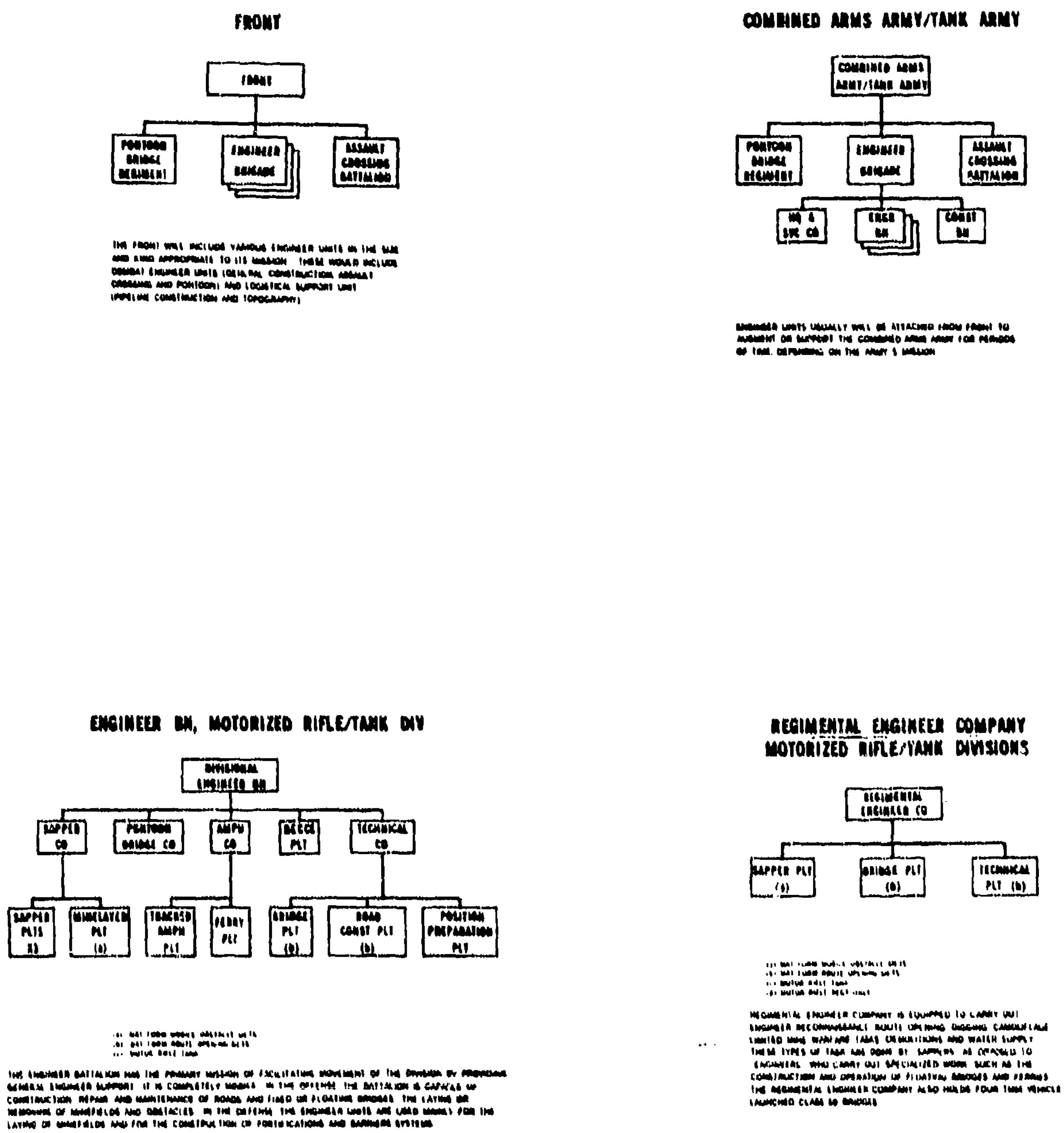

Figure 3. Soviet Engineers Organizations

During mining operations, it is Soviet doctrine to attach an engineer mine-laying platoon to an infantry company or battalion. At company level they will mine a front of 1 to 5 kilometers; at battalion level they will mine a front of 8 to 10 kilometers wide. The depth for minefields will generally not exceed 5 or 6 kilometers for the mine or sapper platoon.

Multiple platoons and companies of engineers are quickly grouped to accomplish large-scale mine operations. Basic Soviet doctrine directs that mines will be used in both offensive and defensive operations at any cost, and that mines will be emplaced even when the unit is under enemy weapons fire and during night operations.

Soviet division engineers are primarily designated as sappers and are organized at battalion level with approximately 350 men. The divisional engineer battalion is highly mobile with its tracked and wheeled vehicles, and fully equipped with demolition sets, mine detectors, grapples, flame throwers (which can burn trip wires) , and motorized mine-emplacement equipment. One engineer battalion can provide 36 obstacle-clearing sections to clear up to 36 lanes through a minefield. These lanes are intended to permit penetration by 12 to 18 companies or approximately 4 to 6 tank or motorized rifle battalions.

Several interesting contrasts emerge when Soviet and U.S. mining and countermining operations are compared. For example, the Soviets still appear to favor the massive use of mines and are prepared to commit extensive resources and manpower to emplace them. U.S. military thinking tends toward a more selective use of scatterable mines at opportune times and places. Both U.S. and Soviet forces will use mines before and <u>during</u> battles.

The Soviets have incorporated numerous minefield clearing devices in their combat units. Their engineer battalions are well trained and expect to encounter and clear lanes through minefields. However, their current equipment appears to be designed for use against the pressure or tilt-rod fuzed mines of World War II vintage. The Soviet reliance on rollers and plows, explosive hoses, etc. could emanate from a common propensity among military technicians to design countermeasures against their own weapons. Or, more probably, it may reflect the best choice from a bad set of countermining alternatives. In any event, the Soviets know they will encounter mines and are prepared, however effectively, to engage in extensive countermining operations. As will be explained in the following section, U.S. forces have not attained a comparable level of countermining preparedness.

SECTION IV

U.S. COUNTERMINING CAPABILITIES

A. INTRODUCTION

To assure a high probability of success on the battlefield, U.S. and NATO commanders must maintain tactical mobility. They must be able to out-maneuver the larger Soviet and Warsaw Pact forces and quickly strike with lethal firepower at a time and place of their choosing. To gain and maintain this mobility means planning for and overcoming both natural and enemy-emplaced obstacles.

During any combat operation the commander will expect to encounter obstacles to mounted combat operations. Natural obstacles such as woods, rivers, or canals, will be identified during map and visual reconnaissance operations, and plans will be made to bypass or counter the known obstacles. (Rivers in Central Europe are prime examples of natural obstacles to tactical mobility:[1] there are water barriers up to 100 meters wide every 50 kilometers, and up to 300 meters wide every 200 kilometers.)

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1 James E. Deaton, "The Military Engineer", "Engineering Capabilities of the Soviet Warsaw Pact Armies", November-December 1979, page 418.

An unexpected encounter with dynamic obstacles such as scatterable mines will cause a different set of problems for the commander. Mines not only delay and disrupt a unit's tactical mobility, but they also have the capability of wounding or killing personnel and disabling equipment. Conventional mines are usually emplaced before the battle starts, while scatterable mines are emplaced both before and during the battle to gain the element of surprise against the opposing force.

The general availability of sophisticated, electronically fuzed mines is evident from advertisements in a recent issue of "International Defense Review," Volume 13, Number 9. The advertised mines use advanced fuzes and firing devices to detonate under high priority targets such as tanks, self-propelled artillery, air defense weapons carriers, armored combat vehicles, and similar items of equipment.

It is evident that Russia and her Warsaw Pact Allies possess and will make extensive use of scatterable mines. During the period 1947 to 1949 Soviet advisors trained North Korean troops in mine warfare.[2] There are indications that Soviet advisors also taught mine warfare to Egyptian and Syrian troops prior to the Arab/Israeli (October) War of 1973.

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[2] Department of the Army, "Landmine and Countermine Warfare Korea, 1950-1954", Engineer Agency for Resources Inventories, Washington, D.C., June 1972, page 87.

The implication of the preceding paragraphs is that highly sophisticated mines are proliferating throughout the world. The Soviets and their Warsaw Pact allies, of course, are fully capable of producing their own scatterable mines and have unquestionably done so. However, the so-called "Third World" nations now also have access to effective landmines that can be bought on the international weapons market. It is, therefore, essential for U.S. forces to be prepared to undertake countermining operations regardless of who the next military adversary may be.

The current state of U.S. countermine preparedness is addressed in the following Subsection.

B. U.S. MINE DETECTORS AND MINE-CLEARING EQUIPMENT

The effectiveness of mechanized forces can be severely crippled by their opponent's use of landmines. For example, in Vietnam, both guerilla (Viet Cong) and NVA Main Forces extensively used mines against U.S. and ARVN vehicles and personnel. A study of the six-month period from November 1968 to May 1969 stated that 73 percent of all tank losses and 77 percent of all armored personnel carrier losses were caused by mines.[3] From June 1969 to June 1970, the 11th Calvalry encountered over 1,100 mines in the northern III Corps Tactical Zone. Only 60 percent were detected; the other 40 percent accounted for the loss of 352

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[3] Starry, Donn A., "Mounted Combat in Vietnam," Department of the Army, U.S. Government Printing Office, Washington D.C., 1978, page 79.

combat vehicles.[4] General Donn A. Starry states in his book "Mounted Combat in Vietnam," that the U.S. must find better ways to deal with landmines based on their deadly effect. General Starry further stated that anti-armor landmines have historically been a persistent problem for which no really satisfactory solution has been found.[5]

With the above comments in mind, it is germane to review the mine-detection and mine-clearing capabilities of the U.S. Army.

1. Mine Detectors

Table 2 lists the quantity and type of mine detectors now issued to U.S. combat units at company and battalion level. Table 2 also lists the quantity and basis of issue or quantity of hand-held mine detectors issued to company and battalion size U.S. units.

There are two types of standard U.S. mine detectors:

- o AN/PSS-11 Metallic Mine Detector which detects metal objects.

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4. Ibid, page 79.
5. Ibid, page 223.

TABLE 1

U.S. ARMY CURRENT COUNTERMINE CAPABILITY

MINE DETECTOR SETS AUTHORIZED PER COMBAT UNIT*

UNIT	TYPE MINE DETECTOR	QUANTITY
TANK BATTALION (Armd & Mech Inf Div)		
Detecting Set, Mine	PTBL AN/PRS-7	5
Detecting Set, Mine	PTBL AN/PSS-11	5
Headquarters & Headquarters Company	PTBL AN/PRS-7	1
	PTBL AN/PSS-11	1
Combat Support Company	PTBL AN/PRS-7	1
	PTBL AN/PSS-11	1
Tank Company	PTBL AN/PRS-7	1
	PTBL AN/PSS-11	1
MECHANIZED INFANTRY BATTALION (Armd & Mech Inf Div)		
Detecting Set, Mine	PTBL AN/PRS-7	1
Detecting Set, Mine	PTBL AN/PSS-11	3
Headquarters & Headquarters Company	PTBL AN/PRS-7	1
	PTBL AN/PSS-11	3
Combat Support Company	None	None
Mechanized Infantry Company	None	None
INFANTRY BATTALION		
Detecting Set, Mine	PTBL AN/PRS-7	1
Detecting Set, Mine	PTBL AN/PSS-11	3
Headquarters & Headquarters Company	PTBL AN/PRS-7	1
	PTBL AN/PSS-11	3
Combat Support Company	None	None
Rife Company	None	None
ARMORED CAVALRY SQUADRON (Armd & Mech Inf Div)		
Detecting Set, Mine	PTBL AN/PRS-7	11
Detecting Set, Mine	PTBL AN/PSS-11	20
Headquarters & Headquarters Troop	PTBL AN/PRS-7	1
	PTBL AN/PSS-11	1
Armored Cavalry Troop	PTBL AN/PRS-7	3
	PTBL AN/PSS-11	3
ENGINEER BATTALION (Armd & Mech Inf Div)		
Detecting Set, Mine	PTBL AN/PRS-7	48
Detecting Set, Mine	PTBL AN/PSS-11	50
Headquarters & Headquarters Company	PTBL AN/PRS-7	4
	PTBL AN/PSS-11	5
Combat Engineer Company	PTBL AN/PRS-7	10
	PTBL AN/PSS-11	10

* "ARMOR REFERENCE DATA", Volumes I and II, U.S. Army Armor School, Ft. Knox, KY, 1979.

o AN/PRS-7 Nonmetallic and Metallic Mine Detector which detects a change in the density of material under the search head.[6]

These are one-man, portable mine detectors designed to be used by one soldier walking on the battlefield looking for mines. The soldier with the mine detector will only locate mines. FM20-32, "Mine Countermine Operations at Company Level," recommends that "Operators should be relieved after short periods of time to keep them from getting 'tone deaf' to the signals of the headset," (page 68). Other soldiers or teams will move forward to mark, defuze, detonate, or destroy those mines which have been located. It is possible to envision a platoon, a company, a combined arms team, or even a battalion waiting to move while several, extremely vulnerable, walking soldiers attempt to clear a path through a minefield. Clearing is to be accomplished by using separate explosive charges, bangalore torpedos, or line changes to open small paths.

It must also be recognized that minefields emplaced by either enemy or friendly forces pose a threat. A U.S. or NATO unit could easily encounter a minefield emplaced by friendly forces because of the wide areas of maneuver which are anticipated during any future war. U.S. and NATO combat units will therefore require reliable mine-clearing equipment to be immediately available to clear minefields, regardless of which force emplaced them. Clearly, the current U.S. doctrine of using hand-held mine detectors is not commensurate with U.S. doctrinal concepts which dictate a high degree of mobility and speed.

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[6] U.S. Army Field Manual, FM20-32, "Mine/Countermine Operations at the Company Level", Headquarters, Department of the Army, Washington, D.C., November 1976, page 67.

The mechanized infantry company and the infantry company do not have mine detectors, nor do their respective combat support companies. In these two instances, a total of four mine detectors exist at each of the respective battalions. When considering the speed, tempo, distances, and obvious countermine requirement expected on the modern battlefield, a total of four mine detectors for an Infantry or Mechanized Infantry Battalion is neither practical nor realistic for effective countermine warfare.

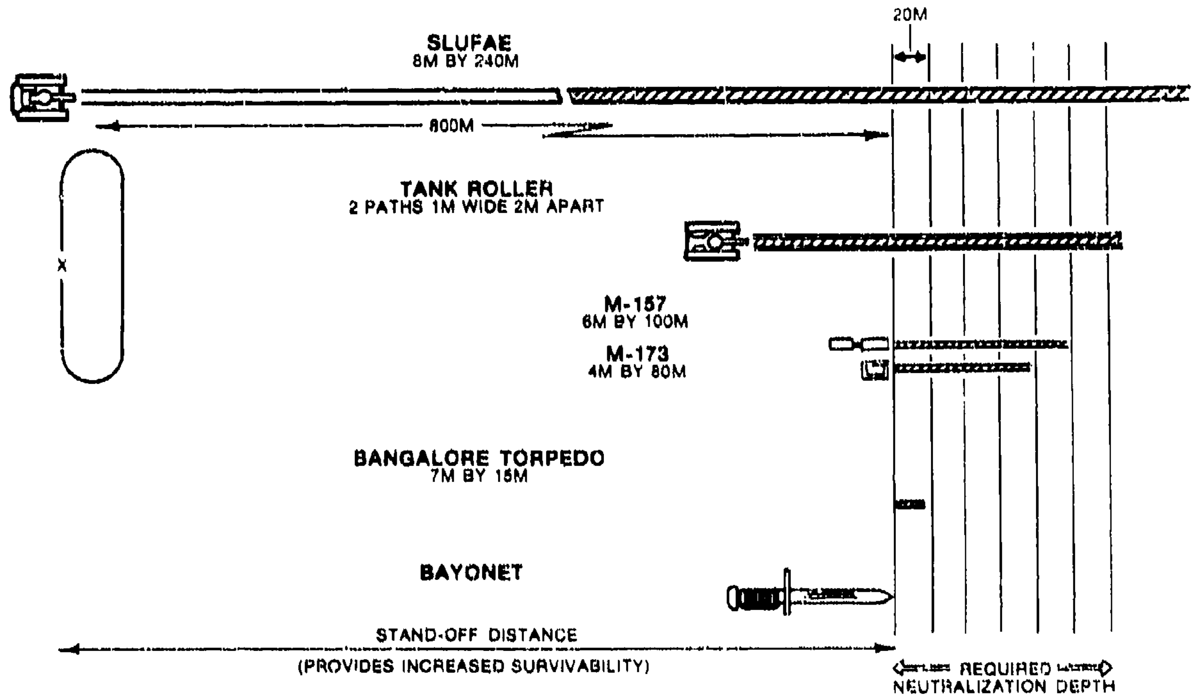
The tank battalion has a total of ten mine detectors and the mechanized infantry battalion has a total of four mine detectors. Both battalions are regarded as "cutting edge" units and will constitute the bulk of U.S. Army combat power. This small quantity of mine detectors is not sufficient to maintain the speed and mobility that will be expected on the modern battlefield. It is again easy to envision these units, with their inherent combat power, being delayed on the battlefield while slowly and deliberately attempting to clear a path lane through a minefield.

A similar problem exists with the tank battalion. There are 54 tanks allocated to the battalion, based upon the current TO & E, as well as numerous additional combat and combat support vehicles. These additional vehicles are critical to the combat mission of the battalion and are expected to move with the battalion during all combat operations. Yet there are only ten mine detectors issued to a full-strength tank battalion. This problem must again be regarded as critical when considering the threat of large, dense minefields being emplaced by the Soviet and Warsaw Pact nations.

Another problem exists regarding the allocation of the limited number of mine detectors issued to a tank battalion. If one or more tank companies encounter mined areas, the battalion commander must determine which companies receive mine detectors and in what quantity. Furthermore, the battalion organization itself may not remain intact. During any formation of task forces or the formulation of combined arms teams, elements or companies of the tank battalion may be sent to join a mechanized infantry battalion. The inherent mobility and tactical effectiveness of the tank company may be lost because of the lack of sufficient quantities of mine detectors. A tank battalion commander is not likely to release any of his countermine or mine-detector equipment and/or personnel to accompany a tank unit that was sent to join a combined arms team. Thus it is possible that a detached tank company, sent to join a mechanized infantry battalion, could find itself in a battalion-size unit with only four mine detectors. The reverse is true in that a mechanized infantry battalion commander may not release one of his four mine detectors or personnel to accompany a company sent to join a tank battalion to form a combined arms team. The problem becomes even more complex when considering what could occur at platoon level if tank and infantry platoons were to be cross-attached to form combined arms platoons.

2. Mine-Clearing Equipment

Figure 4 illustrates some of the U.S. existing and projected systems for mine neutralization on the battlefield. The lower end of the scale, in terms of combat speed and vulnerability (and age), is represented by the bayonet and bangalore torpedo. Both of these items were used during World War II and were only marginally effective. It is readily apparent that they do not meet the modern requirements for speed and survivability which are essential today.



SOURCE: U.S. ARMY ENGINEER CENTER, FORT BELVOIR VA

Figure 4. Current U.S. Mine Countermeasures and Neutralization System Capabilities

The M-157 mine-clearing charge consists of 79 five-foot sections of explosive charge, with each section weighing 150 pounds. It is designed to be assembled by hand, section by section, and then towed or dragged to the near edge of the minefield. At that point it is pushed into the minefield by a tank. The entire system weighs approximately six tons, and requires approximately eight man hours to assemble. It is detonated by a .30 or .50 caliber bullet being fired into a striker plate, which in turn fires the explosive in the line.

The M-157 is intended to clear a path approximately 6 meters wide by 100 meters long. The system is a logistical burden and is subject to malfunctions resulting from its movement to the minefield or the process of pushing up to 79 connected sections into a minefield. The crew, transport vehicle, tank, and the extended line charge are all highly vulnerable to enemy detection and weapons fire as the device is moved into position and then pushed into the minefield. There are approximately 1,100 of these devices in the Army inventory.

The M-173 mine clearing system is similar to the M-157 in that it is an explosive line charge. The M-173 is mounted on a fiberglass sled which is towed or pushed to the edge of the battlefield. A rocket propels the line charge into the minefield. The explosive charge is then fired to clear a path approximately 4 to 5 meters wide by 80 meters long.

The M-173 device weighs approximately 3,100 pounds. It suffers from the same limitations of the M-157 device in that it is bulky, cumbersome, slow, and highly vulnerable to enemy weapons fire. There are approximately 360 M-173 devices in the Army inventory.

The tank mine roller weighs approximately 10 tons and is designed to be fitted to the front of a tank. The rollers will clear two one-meter wide lanes separated by a distance of two meters. The roller will neutralize single-impulse, anti-tank pressure-fuzed mines. The planned basis of issue is for 3 roller-fitted tanks per tank battalion with ten such tanks scheduled to arrive in Germany in late 1981. This device provides mobility, speed, and armor protection during mine-clearing efforts, but its effectiveness against mines that use magnetic-influence fuzes is questionable. The belly of the tank remains vulnerable due to the two-meter open space between rollers.

The SLUFAE, or Surface Launched Fuel-Air Explosive system, consists of a 30-tube launcher mounted on a M-548 carrier. A combat engineer support vehicle (CESV) is incorporated in the system. Fuel air rockets, which weigh 90 pounds, are fired individually or ripple-fired to clear a path approximately 8 meters wide by 240 meters long. While SLUFAE is vulnerable to enemy artillery and direct-fire weapons, it can be fired from concealed positions. It provides a stand-off of 350 to 800 meters. Originally designed for use by a combat engineer battalion, a firm basis of issue has not yet been established. It has been type classified standard but there are no projections of when it will be fielded for troop use.

VEMASID (Vehicle Magnetic Signature Duplicator) is currently in development. This equipment is designed to duplicate a vehicle's magnetic signature and project it ahead of the vehicle. Intended for use against mines that employ magnetic-influence fuzing, it does not interfere with the vehicle's mobility or combat capabilities, and can be used in conjunction with other neutralization devices such as rollers to further enhance a full-width mine-clearing capability.

The comparison of mine-clearing technology indicates that the U.S. appears to be somewhat ahead of the Soviets and their Warsaw Pact allies. In many cases, both sides are pursuing similar approaches to the problem: rollers, plows, mechanical line charges, and rocket-propelled line charges. Although the Soviets are known to be pursuing the use of fuel-air explosives as an air-delivered weapon[7] there is no evidence that their technology is keeping pace with U.S. progress in this area. Nothing is known regarding the Soviet's capability or inclination to field a magnetic-signature duplicator like VEMASID.

The Soviets enjoy a considerable advantage when their countermining capabilities are compared to those of the U.S. on the basis of equipment actually fielded. Soviet combat units are well equipped with rollers and plows, and have ready access to other types of mine-clearing devices. At the present time, U.S. forces are inadequately equipped to perform rapid and efficient countermining operations.

Finally, there are indications that the Soviets think of countermining operations in a systems context. (In this sense, a countermining system comprises the elements of mine detection, communication of the threat, and mine neutralization.) For example, every third or fourth Soviet tank is equipped with the KMT-5M plow/roller combination. The plow and roller cannot be used

[7] "Aviation Week & Space Technology," 16 March 1981, page 60.

simultaneously. When the Soviets think they are entering a minefield, the roller is probably used first. If the roller detonates a mine, thus confirming the presence of a minefield, the roller is probably raised and the plows are lowered. Flares may be launched from the tank that encountered the first mine to alert the crews in other tanks. This "system" is also known to include lane-marking devices for night operations. While this combination of equipment is not particularly sophisticated, it is indicative of a sound systems approach in which available resources are employed in an orderly, efficient manner to perform their intended mission.

There are few indications that U.S. forces have used a similar systems approach in organizing countermining tactics and operations.

SECTION V

SCENARIO

A. INTRODUCTION

This section of the report will present scenario to illustrate some potential applications of countermine warfare equipment. The scenario will depict combat situations common to offensive, defensive, retrograde, and covering force operations where landmines would be normally employed by both friendly and enemy units. The scenario will address a conventional, mid-intensity combat environment in Central Europe involving U.S. and NATO units opposing a Soviet and Warsaw Pact invasion force. The scenario will not include nuclear, electronic, or chemical warfare situations.

The objective of the scenario is to illustrate how U.S. and NATO countermine equipment can be used to maintain battlefield mobility for friendly units and how dynamic obstacles can be overcome. The scenario is based on the assumption that friendly and enemy forces have both conventional and scatterable mines, have the means (air and ground) to emplace them and have the logistical systems to support large-scale mining operations. Some potential Soviet tactical applications for mine warfare during offensive and defensive engagements are illustrated in Figure 5.

When considering a Soviet attack directed against Central Europe, several factors must be recognized. The Soviets know and understand the NATO plan of

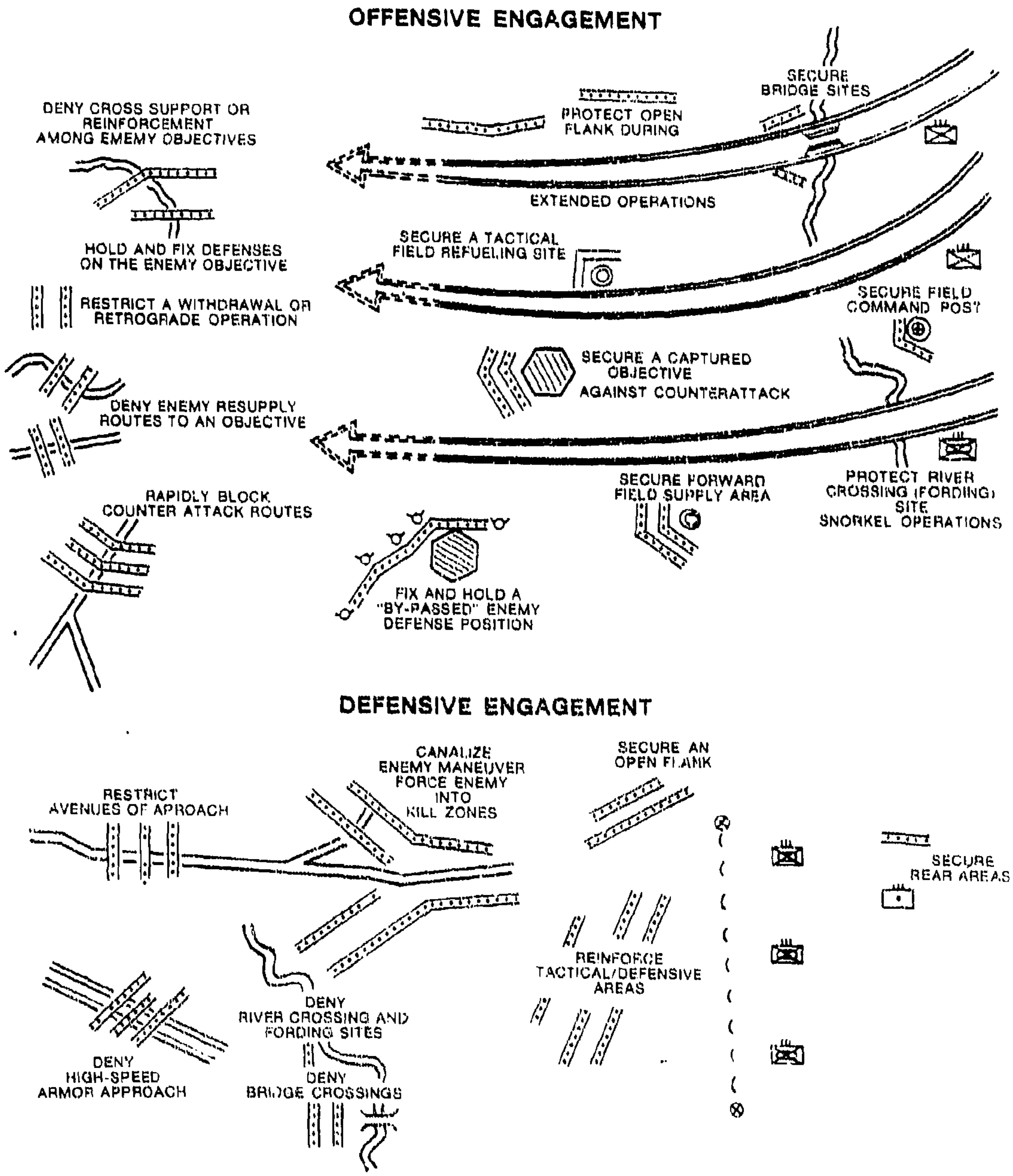


Figure 5. Potential Soviet Tactical Mine Use

"forward doctrine." Their intelligence efforts have, no doubt, included specific areas for each NATO unit and well educated guesses for the NATO defensive concept.

Any concentrated Soviet attack could penetrate the NATO forward defensive positions, isolate key NATO defensive positions with flanking and enveloping attacks, and move deep into rear areas. The Soviet attack would avoid strongly defended positions and concentrate on weak or open areas along NATO's defensive line.

After a penetration is made, Soviet forces, primarily motorized rifle and tank units, would move to isolate and bypass NATO defending units and concentrate on deep penetrations to exploit their initial success. The deep penetration would attack rear-area supply lines, command centers, and communication and logistics centers.

Initially, the U.S. Army "active defense" would be reduced to moving battalion and brigade-size units in an attempt to reinforce other units or to stop a Soviet penetration. U.S. and NATO counterattacks would consist of attacks against Soviet units that were reduced or weakened by defensive fires.

In the development of the scenario which follows, U.S. Army Field Manual (FM) 100-5 with Change 1, dated 1 July 1976, was extensively used. This document sets forth the basic concepts of U.S. Army Doctrine. It is the foundation for teaching in U.S. Army Service Schools and serves as the guide for training and combat developments throughout the Army.

B. GENERAL SITUATION

1. Enemy

Soviet and Warsaw Pact military forces have initiated an attack against Western Europe. Sovet and Warsaw Pact forces have moved from assembly areas located in Russia, Poland, East Germany, Czechoslovakia, and Hungary, and have begun their attack into West Germany and Austria. International border crossings were made one week after a massive buildup of forces and mobilization operations under the pretense of "war games" and combined training exercises. River crossings were made without delay, and Soviet Army Fronts consisting of multiple Combined Arms Armies (CAA) penetrated approximately 20 kilometers into Western Germany before meeting any significant or effective resistance. One Soviet element, believed to be the Soviet 8th Guards Army, is operating in the southern sector and has moved into the Fulda Corridor and taken the City of Fulda. It appears that this unit, with probable assistance from other Soviet units, will direct their attack toward the city of Frankfurt.

The Soviets have not yet used tactical nuclear weapons. They presently have air superiority, but have lost a large number of aircraft.

2. Friendly

The U.S. forces in Western Europe have been fully mobilized and have responded to the Soviet and Warsaw Pact attack. Both U.S. and NATO forces have had advance warning of the attack and confirmed the warning as authentic approximately four days prior to the border crossing. The U.S. Vth and VIth Corps are fully combat ready in Germany. Vth corps is operating from Bonn and VIIth Corps is operating from Stuttgart.

NATO Headquarters is established at Bruxelles (Belgium) and the NATO Allies have established their respective Corps Headquarters at predesignated cities in West Germany and France. Full mobilization of the NATO Allies continues within their respective home countries and additional NATO forces are expected within ten days.

C. TASK FORCE DELAY SCENARIO

A U.S. Army mechanized infantry brigade is conducting a delay operation in its assigned sector. The brigade anticipates a Soviet attack by motorized rifle division in approximately three hours. The brigade consists of two mechanized infantry battalions and one tank battalion; each battalion is at full combat strength.

Three battalion-size task forces have established defensive positions across a forty-five kilometer front. Elements of the third task force are operating approximately twenty kilometers forward of the Forward Edge of the Battle Area (FEBA) in a covering force mission. Mobility will be essential to this operation.

The covering force has four basic tasks:

- o Force the enemy into revealing the strength, location, and general direction of his main attack. The covering force will destroy enemy reconnaissance and advance guard elements.

- o Deceive the enemy and prevent the enemy from determining the strength, disposition, and location of friendly defensive positions, especially in the main battle area.

- o Destroy the enemys' air defense cover or force enemy air defense units away from their main attack element.

- o Gain time for friendly main force units - trade space for time.

The brigade is deployed as depicted at Figure 6.

The brigade and battalion commanders have considered the factors of METT (Mission, Enemy, Troops available, Terrain and Weather) in establishing their respective battle positions. Multiple battle positions have been selected and prepared with alternate battle positions identified further to the rear. The fire plan has been prepared and provides for interlocking fires among the battalions. It also includes artillery fires, and provides for close air support and attack helicopter weapons fires, and the use of scatterable mines (air, ground, and artillery-delivered).

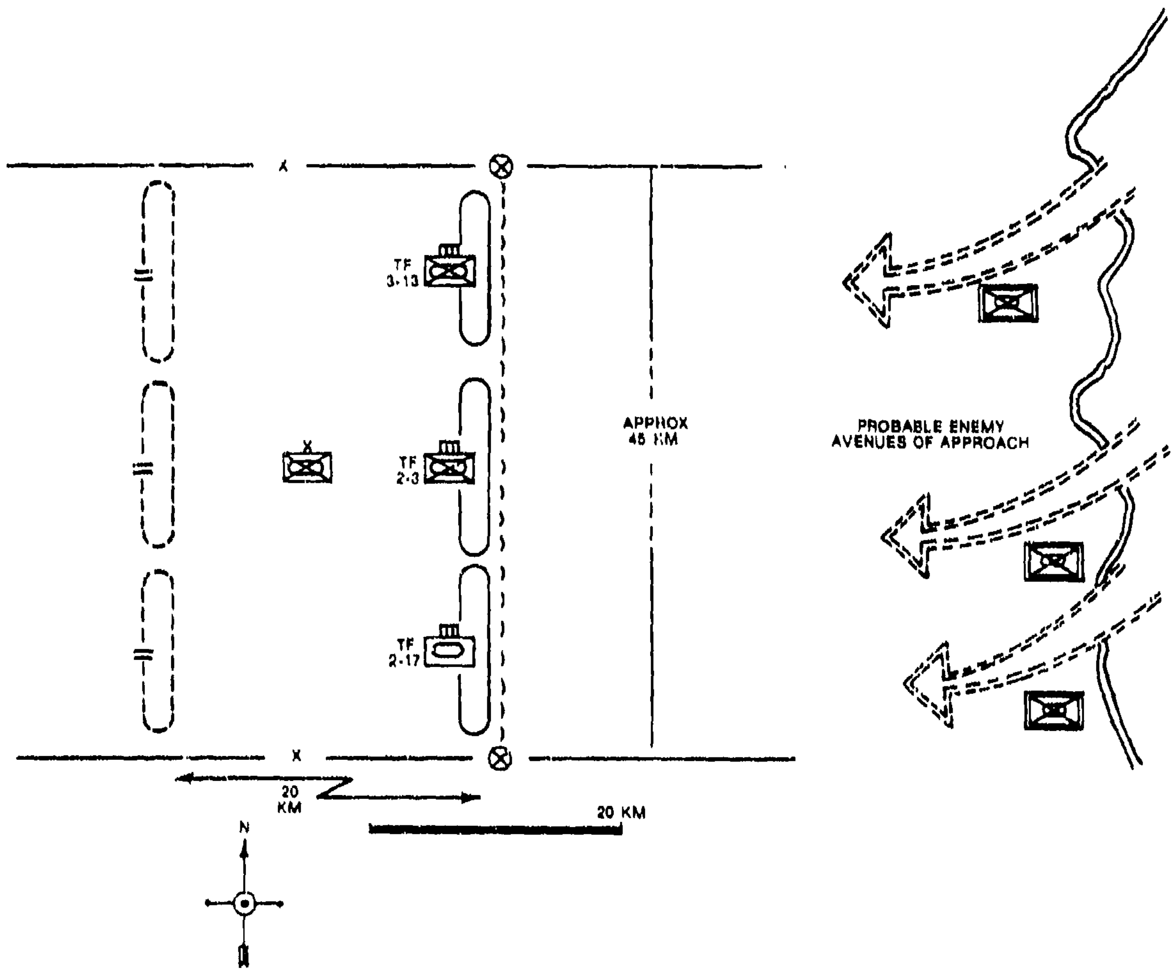


Figure 6. Brigade Tactical Deployment

The brigade commander plans to move his battalions from one battle position to another as the battle develops. His delay operation will be flexible, attempting to absorb the shock of the attack and then halting it. Some enemy elements will undoubtedly breakthrough and attempt to reach rear areas. Dragon and LAW Antitank Guided missiles (ATGM) will be used in rear areas to slow these penetrating forces.

Each weapon will be positioned to take advantage of its range and to minimize its vulnerability to enemy suppressive fires. Each battle position must combine the characteristics of a defense and an ambush. Several battle positions in mutual support are expected to multiply the strength and value of each position.

The covering force will normally have the mission of fighting in a specified area for a specified period of time. This can be in hours or days, but must provide adequate time for the main body to complete a particular action. Tactical air support should also be used to increase the survivability and augment the combat power of the covering force. While operating far forward of the FEBA, the covering force must also have an immediate mine-clearing capability to move through both friendly and enemy mined areas.

Heavy overcast and dense fog conditions have obscured the battle area. Aircraft reconnaissance and surveillance have not been possible and ground-based radar sets do not provide adequate tactical information. The division armored cavalry squadron is committed in another area.

In an effort to gain information, prepare for the anticipated attack, and maintain contact with the enemy, the brigade commander directs that covering forces be employed. Elements of Task Force 2-17, currently deployed forward in the southern sector, are ordered to continue moving east, cross the river, and establish contact with the enemy. Task Force 3-13, deployed in the northern sector, is directed to send a company team forward to the river in an attempt to gain information, establish contact, and engage forward elements of the advancing enemy force.

TF 2-17 moves forward approximately 20 kilometers, crosses the river, and reports the approach of a Soviet reconnaissance unit. Engineers with the reconnaissance unit have emplaced a minefield, approximately 100 by 5,000 meters, approximately 2,500 meters south of their avenue of advance. This is an effort to secure the Soviet flank and to provide added protection for a hasty river crossing by the Soviet main body. A Soviet engineer squad has crossed the river and is setting up smoke generating equipment to further obscure their intended river crossing.

TF 2-17 reports the situation in a spot report (SPOTREP), advises its intent to conduct a hasty attack, and concurrently begins to deploy against the Soviet lead elements. It is estimated that the Soviet unit is a motorized rifle regiment. The Soviet engineers have emplaced both pressure and magnetic influenced scatterable mines in this particular minefield. TF 2-17 employs tanks equipped with rollers and Vehicle Magnetic Signature Duplicators (VEMASID) to quickly clear multiple paths through the Soviet emplaced minefield. Two tanks in each platoon have been fitted with rollers and VEMASID devices, thus six paths are quickly opened through the minefield. (See Figure 7.)

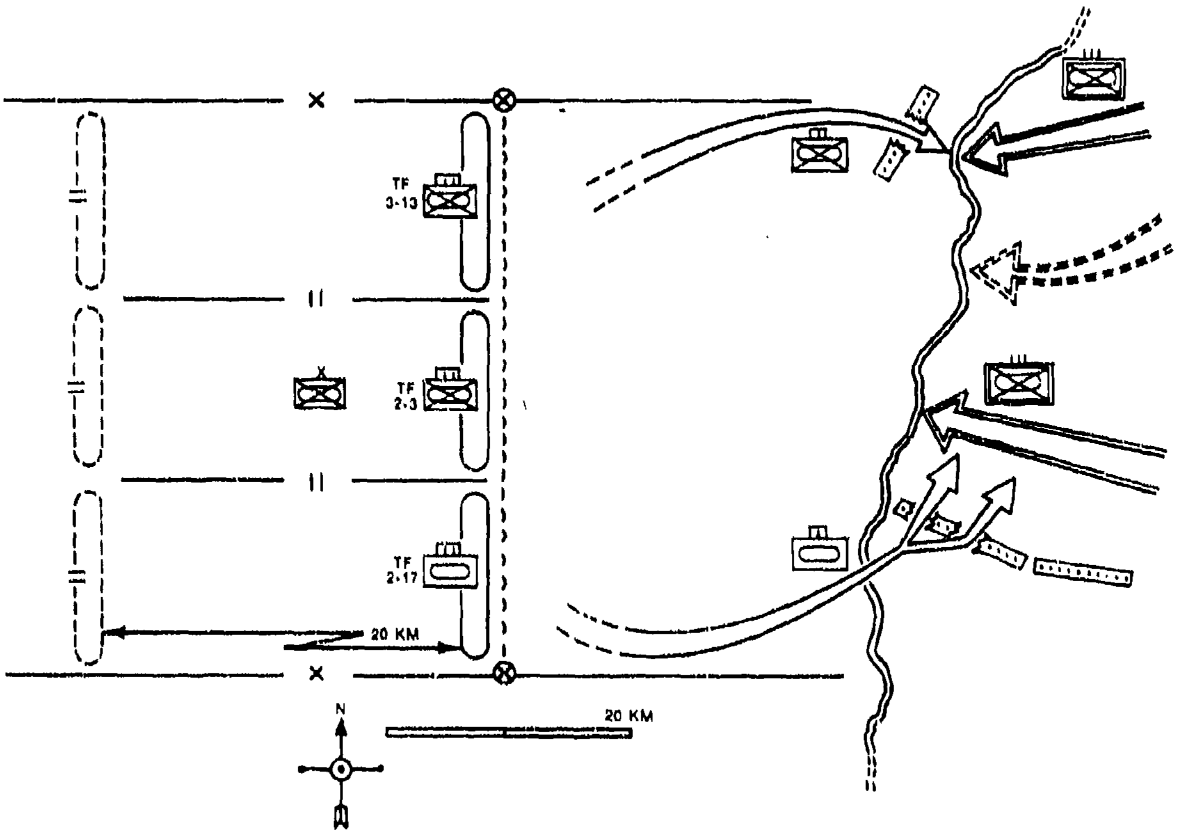


Figure 7. Covering Force Tactical Deployment through Minefields

The Task Force moves forward and deploys to within 2,000 meters of the approaching Soviet column to begin the attack. Task force mortars and TOW weapons do not move through the minefield but remain south of the minefield, establish hasty firing positions, and open fire after the tanks have begun the engagement. Dragons and LAWs are located in hasty positions on both sides of the minefield, as required by the task force commander, and will engage the Soviet force if and when they attempt to maneuver and engage the task force.

The engagement lasts for approximately ten minutes as the Soviet force begins to return fire and maneuver against the task force. On order, the task force begins to disengage and uses rollers and VEMASID to again move through (south) the Soviet emplaced minefield. Task force infantry elements on the far side of the minefield have emplaced MOPMS (Modular Emplaced Mine Pack Systems) packs in positions to close all open lanes after the task force emerges from the minefield. With the return of all task force elements, the MOPMS packs are activated to reseed the original minefield. This delays and disrupts the attempted Soviet pursuit.

The task force quickly regroups and again crosses the river to establish a hasty defensive position. In the ensuing SPOTREP, it is noted that several Soviet tanks and BMP infantry combat vehicles were destroyed in the minefield. No further pursuit by the Soviet force is attempted.

To the north, Team Alpha has moved approximately 20 kilometers toward the river but then encounters a minefield. There is no previous knowledge of this minefield. It is estimated to be a Soviet anti-tank minefield based upon the extensive damage to an M-113A1 infantry armored personnel carrier. Alpha Team

Commander decides to move through the minefield using tanks fitted with rollers and VEMASID to clear three paths for the 20 vehicles of the team. The passage through approximately 100 meters of minefield is quickly accomplished without any further loss of vehicles, though a large number of mines are detonated. On the far side of the minefield the company team regroups and deploys into combat formation.

As the team approaches the river it encounters a Soviet reconnaissance element. The Soviet unit is estimated to be company-size and is reinforced with tanks. Five tanks are observed, as well as an engineer team or section. The Soviet unit is attempting to establish a bridgehead and is preparing for a hasty river crossing by a following main-force unit. A brief firefight ensues. Several Soviet tanks are destroyed and three BMP's are hit and observed burning. One U.S. tank has been hit by a 73mm projectile, but the tank is still operating with one crew member wounded.

The Soviet unit is reinforced by several tanks and BMP's and begins a flanking movement to envelope the U.S. company team. Team Alpha breaks off the engagement and withdraws back toward the brigade lines, again moving through the minefield. Tank-mounted rollers and VEMASID open new lanes through the minefield while other vehicles use the previously opened paths. Team Alpha successfully withdraws and returns to its original task force.

The brigade reconstitutes its defensive position and continues the delay operation against the attacking Soviet motorized rifle division (MRD). The initial action by the covering force elements was successful and provided an additional time to improve both initial and subsequent delay positions. This delay operation also provided additional time for the U.S. Division to complete its plans and operations. The delay did not result in unacceptable combat losses for the brigade, and those losses sustained have been replaced.

The Soviet MRD completes its river crossing and continues its attack (See Figure 8). Additional artillery-delivered scatterable mines (RAAM and ADAM) were emplaced forward of the Forward Edge of the Battle Area (FEBA) by the brigade during the delay. These scatterable mines were emplaced in pre-selected locations during the heavy fog which obscured the battle area. These mines have produced additional losses among the advancing Soviet force.

As the fog begins to lift at noon on the second day, U.S. tank and TOW gunners engage and destroy a number of Soviet tanks, BMP's and combat support vehicles at long ranges. The enemy vehicles have been slowed by the unexpected minefields and are hit by brigade gunners as they attempt to maneuver through the minefield. The Soviets are forced to replace entire battalions due to combat losses. However, the main Soviet forces, two motorized rifle regiments, continue their advance using the two major avenues of approach, secondary roads, and open areas forward of the friendly brigade FEBA.

As the Soviet attack intensifies, the U.S. brigade, in accord with its plans, conducts a retrograde operation to disengage and withdraw to the next delay position. The Soviets become aware of the situation and use BM-21 (122 mm, range 15,000 m), BM-24 (240 mm, range 11,000 m) multiple rocket launchers, and 152 mm towed artillery (range 17,300 m) to emplace scatterable mines on and to the immediate rear of the U.S. battle positions. This is an effort to block and fix the U.S. elements. The Soviet mines use both pressure and magnetic fuzes and are

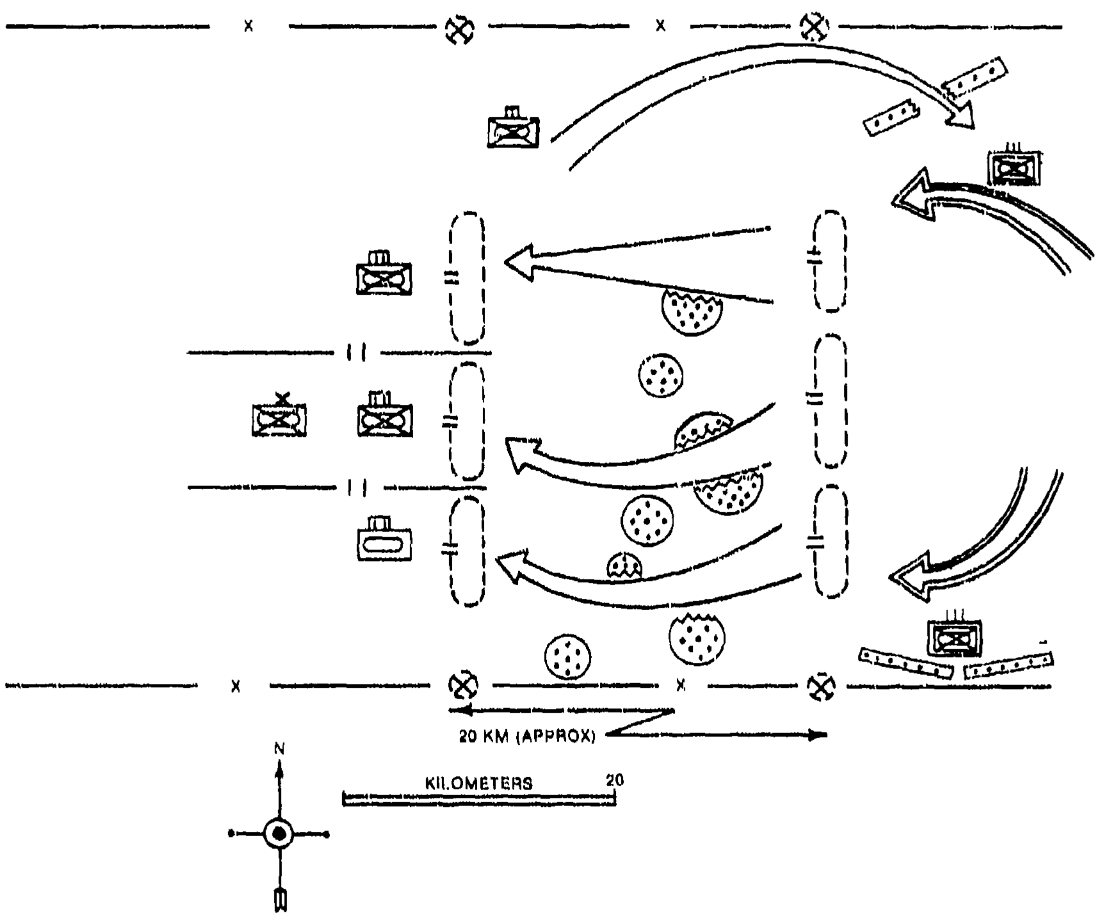


Figure 8. Soviet Employment of Scatterable Mines in the Brigade Main Battle Area

delivered in large quantities. Each projectile contains between 9 and 15 mines and results in dense minefields. Salvos from the BM-21 and BM-24 multiple rocket launchers result in approximately circular mine fields about 1,000 meters in diameter.

The brigade task forces report the Soviet attempt to block and fix them. In addition, they continue their disengagement, and use tank-mounted rollers and VEMASID devices to quickly clear paths through the Soviet-delivered minefields. The U.S. Division support command (DISCOM), located approximately forty kilometers to the rear responds and dispatches four tank transporter trucks ('low boys') forward with each truck carrying one M-60A3 tank fitted with a roller and VEMASID device. The trucks arrive at the friendly position and the tanks move toward the delaying brigade elements, clearing additional lanes through the minefield. With the additional tanks clearing paths through the Soviet-emplaced minefield, the brigade completes its withdrawal and occupies new battle positions. The brigade then renews its delay mission.

During the withdrawal operation the Task Force on the northern position observes that there is an opportunity to conduct a hasty counterattack (See Figure 8). One company team is quickly reinforced with additional tanks. This team moves to the south and begins to maneuver against the northern flank of an advancing Soviet motorized rifle regiment (MRR). The advancing regiment has used engineers to emplace mines to protect its exposed flank. The U.S. company uses its tank-mounted rollers and VEMASID to quickly clear multiple paths through this minefield, thereby gaining an opportunity to engage the exposed Soviet MRR. This hasty attack is successful. Though a rapid engagement, the attack results in several Soviet tanks and BMP's being hit and destroyed by long-range gun fire.

The U.S. company disengages and again moves back through the Soviet minefield and rejoins its parent task force on the new position.

D. LESSONS LEARNED

The scenario presented in the foregoing Subsection is admittedly contrived. It was presented for the purpose of illustrating why countermining equipment is needed, how it can be used, and the impact it can have on the battlefield.

In the scenario, both belligerents were assumed to possess certain capabilities that are not known to be currently available. For example, the U.S. forces were assumed to be equipped with a countermining system comprising VEMASID and rollers. Although the technology for this equipment exists, U.S. forces currently have few rollers and no VEMASID devices.

It was also assumed that the Soviets have mines with magnetic-influence fuzes that can be delivered from multiple rocket launchers. Although there is a strong suspicion that the Soviets possess mines with magnetic fuzes, evidence substantiating this suspicion is not available. The Soviets and their Warsaw Pact allies certainly possess the technology to produce such fuzes. Furthermore, they are known to be highly interested in scatterable mines.

(The delivery system required for scatterable mines -- artillery, fixed-wing aircraft, helicopters, and rockets -- impose payload constraints on the mines. There is an ineluctable tradeoff between effective minefield density and the capacity of potential delivery systems to emplace the mines. Anti-tank mines that use pressure-activated fuzes detonate only if they are run over by a track.

Their probability of encountering a vehicle's tracks is directly proportional to the combined width of the tracks. Mines having magnetic influence fuzes will detonate anywhere underneath the vehicle. Their so-called "lethal width" is thus greater than that of pressure-fuzed mines. Any military power that intends to use anti-tank scatterable mines will inevitably consider the use of magnetic-influence fuzes and subsequently have a high probability of adopting them as standard equipment.)

The Soviets were assumed to use multiple rocket launchers to deliver scatterable mines. Tactical aircraft could also have been used as the assumed delivery system. In this case, the delivery system is not so important as the tactical use of the mines -- they were employed to block the withdrawal of defensive forces.

In the scenario, the covering force comprising TF 2-17 and TF 3-13 used their rollers and VEMASIDs to maneuver through the Soviet's flank-protection minefield. They were thus able to engage the Soviet forces and temporarily break their momentum. This action provided the brigade commander with additional time to strengthen his initial and secondary defensive positions. If neither rollers nor VEMASIDs had been available, the effectiveness of the covering force would have been severely limited and the Soviet motorized rifle division would have quickly closed with the U.S. brigade.

Although delayed, the Soviet attack against the U.S. brigade eventually succeeded. In accordance with its planned delay mission, the brigade initiated a retrograde operation to disengage and withdraw to its secondary position. The Soviets became aware of this operation and attempted to block the withdrawal using scatterable anti-armor mines. (This is commonly called a "hammer and anvil" operation; the attacking force is the "hammer" and the mines are the "anvil.") Once again, the availability of rollers and VEMASIDs enabled the brigade to pass through the minefield and reach their secondary defensive positions. If this countermining equipment had not been available, the brigade would have been overrun and annihilated or sustained heavy casualties while "bulling" through the minefield.

In summary, the scenario depicted a situation in which the Soviets, using scatterable anti-armor mines, were prevented from achieving a decisive victory because the U.S. forces were equipped with rollers and VEMASIDs. This countermining system allowed the U.S. forces to maintain their mobility and successfully execute their delay mission.

SECTION VI

CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

The data presented in Section II, HISTORICAL SUMMARY, indicates that nearly all the tactical and technological trends established in World War II landmine combat are still relevant to contemporary warfare. Mines often proved to be decisive in the outcome of battles and there was a steady evolution of mines and mining tactics as the principal belligerents recognized the value of landmine warfare. From the technological point-of-view, it is interesting to note that World War II saw the advent of scatterable mines -- the Italian "thermos bomb" -- and command detonated mines (used by the Soviets).

A pronounced gap between mining and countermining developments also appeared in World War II. This gap still exists.

The vital role of mines and land mine warfare in World War II has not been well publicized. Mines were used extensively during the compaign in North Africa by both sides to reduce mobility and diminish the "punch" of high speed armored and mechanized attacks. In several instances a well coördinated armored attack was stopped short of the objective by unexpected minefields. Consequently, advancing forces were delayed and suffered casualties inflicted by accurate gunfire from well emplaced defenders.

Landmines played an equally vital, but again, not well publicized, role in the Italian compaign. British, Canadian, and U.S. offensives were repeatedly delayed, disrupted, and stopped by German mines and well situated defensive positions. Allied attacks were planned in detail and often included mechanized and armored forces moving at high speed, but these operations were often reduced to dismounted infantry attacks as efforts to locate and avoid landmines became necessary. The German main force was able to successfully maneuver and withdraw from Italy in a series of delay operations which relied upon mines and the skillful use of terrain.

The Allies were slow to develop countermine equipment and doctrine. The standardized U.S. mine detector used at that time, SCR-625, was not able to detect the German non-metallic mine and U.S. personnel casualties increased.

The success of the Normandy Invasion could have been far different if the Germans had emplaced the original 100 million mines that Rommel had requested for the Atlantic Coast defenses. The Germans used all the mines that were available and in some instances converted artillery projectiles to be employed as mines. Indeed, any type of explosive was obtained and converted into land mines. All barriers and obstacles were reinforced with these crude but highly effective mines and mine expedients. These devices proved lethal and delayed allied advances.

The Soviets refined mine warfare. They adopted and improved basic German mine warfare doctrine and designed improved mines and emplacement methods. They repeatedly used large, dense minefields to delay and destroy German attacks. In some instances, when vehicles were not available, each soldier moving to the front was required to carry at least two mines to be emplaced by engineer troops in large minefields. The battle of Kursk, which was characterized by the extensive use of Soviet landmines, ended German military dominance on the battlefield. The Soviets perfected mine warfare by using landmines during offensive operations to secure their flanks, to protect newly occupied terrain against counter-attacks, and to seal off by-passed units and pockets of resistance.

The effectiveness of German landmines in North Africa and Italy made a profound impression on the U.S. Army. Extensive theater training efforts were expended on mine warfare by the engineers of the Fifth U.S. Army in Europe. The engineers devoted approximately 30 percent of their total training time and approximately 50 percent of their staff training courses to mine warfare.[1] Regretably, this training probably constitutes the high-water mark of U.S. Army interest in countermining.

The lessons learned in World War II were evidently not remembered. General Donn A. Starry, in his 1978 book entitled "Mounted Combat In Vietnam," made the following comments:

> "Fourth among the lessons the Vietnam War offers us is the proof that we still need to find better ways of dealing with land mines. Because of the nature of the war, the enemy was able to do great damage with random mines, some of which were relatively simple. Historically, antiarmor land mines have been a persistent and vexing problem for which no really satisfactory solution has been found. Our failure to solve the problem of mines laid in

1. J. Daley, et al., "Historical Analysis of Mine Warfare," AMSAA Interim Note No. G75, August 1979, Pages 25-26.

patterns has been aggrevated by our similar failure to cope with random mining tactics. We must capitalize, therefore, on the experience the U.S. Army gained in dealing with enemy random mining techniques in Vietnam. We must work out a system for using random mines against armor ourselves. And, finally, since random mining can be used against us again, we should develop equipment for swift search and elimination of such land mines.

Since World War II, almost nothing has been done in this field. The mine rollers sent to Vietnam were not as effective as some 1945 equipment." (Underlining added).

Current Soviet Army organization, training of engineer units as sappers to emplace and clear minefields, and the development and fielding of mine warfare equipment is indicative of the Soviets' current emphasis on mine warfare. Mine-clearing and mine-emplacement equipment is fully compatible with all Soviet combat vehicles. Since World War II the Soviets have emphasized mine warfare to their Warsaw Pack allies, using advisors to teach and explain its advantages.

A clear picture of the Soviets intent to use landmines in large quantities during any future war has emerged. Moreover, the Soviets expect mines to be used against them. They have designed and produced large quantities of mine-clearing equipment, and have provided mine-clearing equipment to regiment and battalion level units. Their offensive and defensive mine equipment is fully mobile, both air and ground transportable, and is in complete consonance with their doctrine for speed, mobility, and a high tempo of operations on the battlefield.

B. RECOMMENDATIONS.

There are six crucial characteristics that a countermining system must possess to effectively perform its mission. In some cases, the needed characteristics appear to be obvious. They are nonetheless presented as a precaution against overlooking them in the future. The set of countermining system characteristics that are needed are as follows:

(1) Countermining devices must be integrated into systems. In this sense, a countermining system comprises the functions of mine detection, communication of the hazard, and mine neutralization.

All three functions -- detection, communication, and neutralization -- are required to breach minefields and maintain the mobility of combat forces. If these functions are not incorporated in a single system, they will tend to be dispersed and the likelihood of not having one or more of these capabilities ready available will increase.

Systems "thinking" also imposes discipline on those who design and develop countermining devices. The propensity toward ad hoc developments, which are later found to be tactically impractical or incompatible with other equipment, is usually reduced when problems are addressed in a systems context.

(2) Combat vehicles that are used to breach minefields must be able to fight while they are clearing mines.

Special-purpose vehicles designed for the sole purpose of mine-clearing have a fundamental weakness. Most minefields will be covered by direct-fire weapons, and vehicles responsible for clearing lanes must be able to fight back to survive. Equipment that seriously impairs the capability of the clearing vehicle to return fire is unsatisfactory.

(3) A high percentage of all combat vehicles, including tanks, armored personnel carriers, and infantry or cavalry fighting vehicles, should be equipped with countermining systems. Depending on the threat situation, ratios between 1 in 5 and 1 in 3 appear appropriate.

Modern warfare stresses the importance of mobility. The delays which mines imposed on mechanized units in World War II often proved decisive in the outcome of battles. In contemporary warfare, such delays would be intolerable. The prospect of dismounted infantry meticulously clearing minefields at less than walking speed, as was often the case in World War II, is totally unacceptable.

(4) Countermining systems should be available for non-combat support vehicles operating in rear areas. It is estimated that about 10 percent of these vehicles should have countermining systems.

The advent of scatterable mines poses a threat to all vehicles. Such mines can be used in both offensive and defensive operations and can easily be employed both near and well behind the FEBA. Even artillery batteries can be fixed in their positions and prevented from moving by scatterable mines.

(5) Countermining systems must be able to neutralize both anti-armor and anti-personnel mines. If the enemy uses scatterable anti-armor mines beyond the range of his direct-fire weapons, it is also highly probable that he will "cover" them with anti-personnel mines. Consequently, any countermining system must be able to cope with both types of mines. (In a future conflict, U.S. forces would inevitably encounter some of their own scatterable mines. These minefields will also contain both anti-armor and anti-personnel mines.)

(6) Countermining systems must be effective against mines using anti-disturbance, pressure-activated, and magnetic-influence fuzes. Evidence indicating that the Soviets have magnetic-influence fuzes for their anti-armor mines is currently not available. However, it is known that they have an interest in scatterable mines. Tradeoffs between delivery-system payload constraints and mine lethal-width tend to drive anti-armor mine designs toward the use of magnetic fuzes.

At this time, a combination of VEMASID and rollers, complemented with SLUFAE, appears to offer the best prospect for a countermining system. It must be recognized, however, that a thorough analysis of roller requirements has not been conducted. For example, trucks and other non-combat vehicles should be protected against the random mines that are likely to be emplaced on roads. These vehicles certainly require a different type of roller than that used by tracked vehicles operating in cross-country terrains.

Serious consideration should be given to the establishment of a Landmine Warfare School. The purpose of this school would be to prepare and teach mine and countermine warfare doctrine and techniques, and to provide a central location for the development of requirements for mining and countermining systems. U.S. forces are neither properly trained nor equipped to conduct countermining operations. This inadequacy was recognized in World War II and exploited by our enemies in Vietnam (as cited in General Starry's comment quoted on a preceding page). A Landmining Warfare School is needed to focus attention on these problems, and ultimately to solve them.

The Soviets and their Warsaw Pact allies are skillful and resourceful adversaries. They will know how to use landmines against the U.S. Army. Yet they are only part of the problem. Sophisticated landmines are now readily available in the international weapons market. They will inevitibly proliferate throughout the world. The U.S. Army must therefore be prepared to conduct successful countermining operations at any time and any place on the globe.

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